Raija Vainionpää

ORAL HEALTH OF FINNISH PRISONERS

UNIVERSITY OF OULU GRADUATE SCHOOL;
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UNIVERSITY OF OULU, OULU 2019
Abstract

In Finland as well as elsewhere, prisoners are a marginal and commonly deprived group of people. Most of them are young or middle-aged males even though the mean age is increasing. Prisoners’ social status and educational background are inferior to the rest of the population. They have many health-related problems. The general health and oral health of prisoners has been previously investigated in other countries, but in Finland information on their oral health is so far scarce.

The aim of this study was to obtain information on aspects of the oral health and associated factors of Finnish prisoners. The study focused on oral health, health- and oral health-related behaviours, dental fear, as well as general health issues. One hundred prisoners (89 male and 11 female) took part in the study between September 2014 and February 2015 in Pelso prison, Finland. A clinical examination including dental caries and erosive tooth wear, periodontal disease, and evaluating and diagnosing temporomandibular disorders was carried out on all participants (n=100). Half of them (46 males and 4 females) were interviewed using questionnaires and Motivational Interviewing Technique. Within interviewing, prisoners’ socio-demographic background factors and information on substance abuse as well as other health- and oral health-related behaviours were obtained. Data on medications was acquired from the prisoners’ patient records. Dental fear and other general fears were surveyed with validated questionnaires.

Substance abuse was common. Almost everyone smoked, and one in every five had used snuff. Pre-prison drug and alcohol use was widespread; drug use was even more prevalent than alcohol use. Almost everyone was taking some prescribed medicine, the most common being antipsychotics, painkillers and sleeping pills. Over half (56%) of the prisoners had hepatitis C.

The oral health status of Finnish prisoners was poor. Almost everyone (81%) had a need for restorative treatment. Signs of periodontal disease were common, with severe periodontal problems found in 7% in the study population. Most required at least preventive treatment due to erosive tooth wear. Temporomandibular disorders, both clinically diagnosed and self-reported, were common. Alcohol use was associated with missed teeth (M). Dental fear was common. Few prisoners went regularly to a dentist. Most of them sought dental care when they had pain or other problems.

Oral health among prisoners is poor and constitutes a risk for general health.

Keywords: dental caries, dental fear, erosive tooth wear, motivational interview, oral health-related behaviours, periodontal infection, prisoner, psychoactive substances, temporomandibular disorders
Tiivistelmä

Suomessa vangit ovat pieni erillisryhmä, joka poikkeaa monella tavalla muusta väestöstä. Suurin osa vangeista on joko nuoria tai keski-ikäisiä miehiä, vaikkakin vankien keski-ikä on nousussa. Vankien sosiaalinen asema ja koulutustausta ovat huonommat muuhun väestöön verrattuna. Vankien yleisterveyttä ja myös suunterveyttä on aiemmin tutkittu muualla, mutta Suomessa tietoa heidän suunterveyden ja siihen liittyvistä tekijöistä on vähän.

Tämän tutkimuksen tarkoituksena oli saada tietoa suomalaisten vankien suun ja hampaiston terveydestä ja siihen vaikuttavista taustatekijöistä. Tutkimuksessa kartoitettiin vankien suunterveyttä ja terveys- ja suunterveystottumuksia, hammashoitopelkoa sekä yleisterveyteen liittyviä seikkoja.


Lähis kaikki tupakoivat, ja nuuskaa oli käytäntö joka viides. Huumeiden ja alkoholin käyttö ennen vankeusaikaa oli ollut yleistä, huumeiden käyttö jopa alkoholin käyttöä yleisempään. Melkein kaikki käyttivät jotain reseptilääkkeet; käytetyimpiä olivat psykoosi-, kipu- ja unilääkkeet. Tutkimuksessa vangeista yli puolet (56%) oli C-hepatiitti.


Suunterveysteen liittyvät ongelmat ovat vangeilla yleisiä ja ne ovat riski yleisterveydelle.

Asiasanat: hammashoitopelko, hampaiden kuluminen, karies, motivoiva haastattelu, parodontaliliinfektio, purentaeliitimöö häiriöt, päihteiden käyttö, suunterveystottumus, vanki
To Elina, Samuli and Veku
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1st November 2019

Raija Vainionpää
### Abbreviations and definitions

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<tr>
<td>BEWE</td>
<td>Basic Erosive Wear Examination</td>
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<tr>
<td>BOP</td>
<td>Bleeding on Probing</td>
</tr>
<tr>
<td>BW</td>
<td>Bitewing radiography</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
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<tr>
<td>CPI</td>
<td>Community Periodontal Index</td>
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<tr>
<td>D</td>
<td>Number of decayed teeth</td>
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<tr>
<td>DAS</td>
<td>Dental Anxiety Scale</td>
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<tr>
<td>DC/TMD</td>
<td>Diagnostic Criteria for Temporomandibular Disorders</td>
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<tr>
<td>DD</td>
<td>Disc displacement</td>
</tr>
<tr>
<td>DJD</td>
<td>Degenerative joint disease</td>
</tr>
<tr>
<td>DMFT</td>
<td>Number of decayed, missing and filled teeth, represents past and present caries experience</td>
</tr>
<tr>
<td>DVAS</td>
<td>Dental Visual Analogue Scale</td>
</tr>
<tr>
<td>EMCDDA</td>
<td>European Monitoring Centre for Drugs and Drug Addiction</td>
</tr>
<tr>
<td>ETW</td>
<td>Erosive Tooth Wear</td>
</tr>
<tr>
<td>F</td>
<td>Number of filled teeth</td>
</tr>
<tr>
<td>FOTI</td>
<td>Fibre-optic transillumination</td>
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<tr>
<td>GERD</td>
<td>Gastro-oesophageal disease</td>
</tr>
<tr>
<td>GFS</td>
<td>Geer Fear Scale</td>
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<tr>
<td>HBV</td>
<td>Hepatitis B</td>
</tr>
<tr>
<td>HCV</td>
<td>Hepatitis C</td>
</tr>
<tr>
<td>HIV</td>
<td>Human immunodeficiency virus</td>
</tr>
<tr>
<td>ICDAS</td>
<td>International Caries Detection and Assessment System</td>
</tr>
<tr>
<td>M</td>
<td>Number of missing teeth</td>
</tr>
<tr>
<td>MDAS</td>
<td>Modified Dental Anxiety Scale</td>
</tr>
<tr>
<td>MI</td>
<td>Motivational interviewing</td>
</tr>
<tr>
<td>OSF</td>
<td>Official Statistics of Finland</td>
</tr>
<tr>
<td>OR</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SES</td>
<td>Socio-economic status</td>
</tr>
<tr>
<td>THL</td>
<td>National Institute for Health and Welfare in Finland</td>
</tr>
<tr>
<td>TMD</td>
<td>Temporomandibular disorders</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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Original publications

This thesis is based on the following publications, which are referred to throughout the text by their Roman numerals:


In addition to published data in the original articles, some unpublished data are presented.
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1 Introduction

In 2017 in Finland daily number of prisoners was 3035 (Criminal Sanctions Agency), the rate being among the lowest in Europe. In 2018, the prisoners’ prevalence in Finland was 51 per 100,000 inhabitants, in Sweden 59, in Norway 63, in Denmark 63, and in Iceland 37 (Walmsley 2018). Prisoners in Finland and elsewhere are a small, marginalised group of individuals. They often come from lower social classes, suffer from poor socioeconomic conditions, and their education is mostly low (Friestad 2010). Furthermore, prisoners are overrepresented among the users and abusers of psychoactive substances (Fazel et al. 2017, Lintonen et al. 2012). Studies on Finnish prisoners’ general health have been conducted since the 1980s (Joukamaa et al. 2010, Lintonen et al. 2012, Viitanen et al. 2013). Studies from Finland and elsewhere show that prisoners have many health problems, including mental disorders and infectious diseases, and the use of psychoactive substances and medications is common, as are various types of injuries and accidents related to their lifestyle (Viitanen et al. 2013, Heidari et al. 2014, Fazel et al. 2017, Moazen et al. 2018).

Although comparisons between prison studies from different countries are challenging, previous studies reveal that the oral health of prisoners is poor and also poor when compared with non-institutionalised individuals (McGrath 2002, Osborn et al. 2003, Nobile et al. 2007, Heidari et al. 2007, Walsh et al. 2008, Bansal et al. 2012, Decerle et al. 2012, Akaji & Folaranmi 2013, Rodrigues et al. 2014, Priwe & Carlsson 2018). However, the oral health of prisoners in Finland has not been investigated before, even though oral health is essential for general health.

The aims of this dissertation were to examine prisoners’ oral health and its association with health- and oral health-related behaviours and dental fear. Another aim was to assess the prevalence and severity of erosive tooth wear and its association with dental caries and the use of psychoactive substances. Furthermore, the aim was to evaluate the prevalence of self-reported and clinically diagnosed temporomandibular disorders and their associated factors. Information was obtained from clinical examinations and interviews using questionnaires with background information on oral health and health behaviours, dental and other common fears and temporomandibular disorders.

Data were collected from Pelso Prison between September 2014 and February 2015. The study material comprised altogether 100 prisoners: 89 males and 11 females, half of whom were interviewed.
Validated and reliable modern criteria and indices were used for recording clinical findings. For detecting dental caries lesions, the International Caries Detection and Assessment System (ICDAS) (Ismail et al. 2007) was used, and the same was true for the Basic Erosive Wear (BEWE) index (Bartlett et al. 2008) for measuring and reporting erosive tooth wear. For the first time in Finland, Diagnostic Criteria for Temporomandibular Disorders (DC/TMD-FIN) criteria (Schiffman et al. 2014) were used for evaluating and diagnosing temporomandibular disorders. Dental fear among prisoners was measured using Modified Dental Anxiety Scale (MDAS) (Humphris et al. 1995).

This study provides knowledge of prisoners’ oral health for the use of oral health professionals for planning and implementing prisoners’ oral health care. The time served in prison provides an opportunity to address oral health issues and educate prisoners about oral health and associated factors. This study aimed to gain new information on oral health and associated factors among Finnish prisoners which information can later be used to improve oral health care in prisons.
2  Review of the literature

2.1  Statistics of prisons and prisoners

Globally, the number of prisoners has increased, and the growth in this group of people already exceeds the rate of population growth. At the end of 2018, the number of prisoners was reported to be more than 11 million. The highest prison rates are found in the USA – 655 per 100,000 inhabitants, followed by El Salvador (604/100,000), Turkmenistan (552/100,000), Thailand (526/100,000) and Cuba (510/100,000). The number of prisoners in Finland as well as in other Nordic countries has been among the lowest in Europe. In 2018, the prison rate in Finland was 51 per 100,000 inhabitants, in Sweden 59, in Norway 63, in Denmark 63, and in Iceland 37 (Walmsley 2018).

There are altogether 26 prisons in Finland; 15 of them are closed and 11 open institutions. As in most European countries, the prisons in Finland are run by the state under the administration of the Ministry of Justice. In 2017, the average number of prisoners per day was 3,035, which was 3% less than in the previous year. Violent crimes, for both males and females, are the most common causes for imprisonment. However, drug-related offences are increasing in 2017, one fifth of the prisoners were convicted because of drug-related reasons (Criminal Sanctions Agency 2018).

The gender distribution among prisoners is similar internationally, and it is always different in comparison with general populations. The proportion of male prisoners is high (Walmsley 2018) compared with females, thus several research reports commonly apply only to men (Nobile et al. 2007, Heidari et al. 2008, Heidari et al. 2014, Prive & Carlsson 2018). Males dominate in the Finnish prisoner population as well; the proportion of females is distinctly smaller, in 2017 on average 8% (Criminal Sanctions Agency 2018). Most prisoners are young or middle aged; however, the proportion of older prisoners (over 50 years of age) has been increasing in many prison systems especially in the USA. The reasons for this are still not understood but may be partly explained by the ramifications of aging populations, the imposition of longer sentences, and more restrictive parole policies (Porter et al. 2016).

In Finland, prisoners are categorised as remand prisoners, sentenced prisoners, life sentenced prisoners, fine defaulters, and those sentenced to community services. Remand prisoners are in the pre-trial phase waiting for their possible sentence;
remand imprisonment is thus not a punishment. Imprisonment can be either for a fixed term or a life sentence. A fixed term prison sentence is at least 14 days and at most 12 years long. The average length of the sentence in 2018 was 10.9 months. Life sentence prisoners serve sentences with no predetermined duration, but the average length is 14 years. They can be released on parole, i.e. conditionally released, at the earliest when at least 12 years of the prison sentence has been served. (Criminal Sanctions Agency 2018)

Prisoners can be considered as a marginal group of individuals whose educational background, social as well as socio-economic status (SES), and professional careers are clearly worse than those of the main population (Friestad 2010, Joukamaa et al. 2010, Heidari et al. 2014). Also, lower social classes are over-represented (Andersen 2004, Heidari et al. 2007, Joukamaa et al. 2010.).

Both health and oral health care services for prisoners operate under the Finnish National Institute for Health and Welfare. Prisoners receive both first aid and dental care, providing them with both oral health examinations and other necessary treatments, including preventive care during the imprisonment. Out of the 26 Finnish prisons, 11 have their own dental clinic and in one prison, dental care services are provided in the nearby public health care centre. Prisoners are also transported to the nearest prison dental office for dental care. Dentists, dental nurses and oral hygienists work in either public positions or as hired employees (private oral health care).

In prison studies, factors related to the prison, circumstances in the prison, the prison population, the country and society, and even the time must be considered in study designs, analyses as well as conclusions (Andersen 2004). Therefore, the comparison of prison studies is challenging. The criminal law and criminal justice policies as well as profiles of criminals differ from country to country. Between countries, the status of prisoners and drug policies vary; for example, the number of hard sentences for drug-related crimes has increased in the USA (Lo 2004).

The availability of participants is an advantage when studying prisoners. Prisoners usually participate in studies well and willingly. This has been reported in previous prison studies (Andersen 2004, Joukamaa et al. 2010). The reasons for this are assumed to be, among other things, that participation in research brings variation to the ordinary routines and days of prisoners. Opportunity to be in contact with civilians and a chance to talk about one’s own personal things and problems may also contribute to voluntary participation in studies (Andersen 2004). Longitudinal studies are challenging due to the release and transfer of prisoners to other institutions. In cross-sectional studies, this is not a disadvantage.
2.2 Health of prisoners

2.2.1 International studies

In many countries, the health of prisoners is worse than that of general populations. In their systematic review of 24 studies from 10 countries with a total of 18,388 prisoners, Fazel et al. (2017) stated that substance abuse was highly prevalent among prisoners. The prevalence of alcohol abusers ranged from 16% to 51% in male prisoners and from 10% to 31% in females. One out of four newly incarcerated prisoners (both genders) had alcohol use disorder. The prevalence of drug abusers was higher among females, varying between 30–69%, while the range in males was 10–61%. A Study by Heidari et al. (2008) revealed an even higher prevalence of illicit drug abuse (84%) in England. Scottish prison studies show increased use of psychoactive substances (SOHIPP 2011). A recent study on Swedish male prisoners (n=176) (Prive & Carlsson 2018) showed a high prevalence of smoking (84%) and drug use (71%). However, alcohol abuse was low (13%) among this study population. According to the study by Heidari et al. (2008), at least 80% of English prisoners were smokers. In their recent review including studies from 53 countries, Moazen et al. (2018) reported a high prevalence of human immunodeficiency virus (HIV), hepatitis B (HBV) and hepatitis C (HCV) among prisoners.

In their systematic review, Griffiths et al. (2012) stated that polypharmacy (two or more medicines from the same therapeutic class) and the use of antipsychotics was very common and widespread among prisoners. It has been estimated that one in seven prisoners has a diagnosis of psychosis or clinical depression (Fazel et al. 2016). A study from the UK (Heidari et al. 2014) showed that male prisoners had more chronic medical conditions in comparison to their counterparts in the general population. An Italian prison survey in 2016 found that two-thirds had at least one illness (Voller et al. 2016).

2.2.2 Studies from Finland

The so-called “WATTU” project was carried out in 1985 (Joukamaa 1991) and comprised a basic comprehensive study on Finnish prisoners’ health. The study was the first one of its kind in the world offering data which represented the whole prisoner population of one country (n=903). The study sample was collected by systematic sampling among all prisoners sent to Finnish prisons in 1985. The study
revealed that more than half of the prisoners had mental problems, mainly due to alcoholism (43%) and personality disorders (18%). About 6% of the males and 3% of the females were illicit drug abusers. One fifth of the males (22%) and one third (36%) of the females had some regular prescribed medication. Overall, prisoners had more somatic illnesses than general population (Joukamaa 1991).

Seven years later, a new cross-sectional study with a smaller study group (n=292) showed that mental disorders, and especially substance abuse problems, had increased among Finnish prisoners. In 2002, prisoners’ health information was obtained from their medical records (Criminal Sanctions Agency 2002). This study informed that increased drug abuse problems had caused significant health problems with viral hepatitis and HIV infections: hepatitis C was found in 26% while 1% had HIV infection. These infections are often associated with the use of intravenous drugs, unprotected sex, and unsterile tattooing and piercing (Moazen et al. 2018). Further, a study conducted in 2006 (n=410) (Lintonen et al. 2012) revealed that the proportion of drug abusers had increased remarkably since the previous studies; more than half of the male (58%) and female (60%) prisoners had drug abuse problems. In 20 years, the substance abuse among Finnish prisoners had increased and was tenfold compared with general adult population (Joukamaa et al. 2010). Alcohol abusers comprised more than half of the respondents; 52% of males and 51% of females. Drug abuse and the combined use of various drugs and intoxicants had become more common along with alcohol abuse. Most likely due to smoking, prisoners had more asthma and chronic bronchitis in comparison with general Finnish population since almost all (80%) of the study population in 2006 were smokers (Joukamaa et al. 2010). Mental health problems had also increased, and the regular use of prescribed medicines had doubled in 20 years. Various types of injuries and fractures associated with the prisoners’ way of life were common among the respondents: nearly all (84%) had experienced at least one diagnosed injury (Joukamaa et al. 2010). Similar results were obtained by Viitanen et al. (2013), who reported that the largest group of self-reported lifetime somatic diseases among female prisoners were related to accidents and injuries. The same study found that four out of five women and half of the men used regular medication.

2.3 Oral health of prisoners

Oral health is linked to health and well-being (Peres et al. 2019). Health risk factors, such as smoking, alcohol abuse and drug use, and poor and unbalanced dietary and
health-related habits affect oral health as well. Again, poor oral health has been shown to be associated with chronic diseases, e.g. diabetes, cardiovascular health (Vanwormer et al. 2013), and head and neck cancer (Chang et al. 2013). The relationship between depression and poor oral health in terms of decayed and missing teeth was reported by Coles et al. (2011). There are previous international prisoner studies on the main oral diseases – dental caries and periodontal disease. So far, no previous studies on the oral health of Finnish prisoners exist.

2.3.1 Dental caries and periodontal diseases

Dental caries is a bacterial disease that causes the hard tissue of the tooth to demineralize causing tooth decay. Periodontal diseases are chronic inflammatory diseases caused by pathogenic biofilm. Both these conditions are among the most common diseases globally (Peres et al. 2019). One in five adult Finns has at least one caries lesion needing restorative treatment, while nearly half (47%) of Finns have periodontitis (Suominen et al. 2012).

The oral health studies of prisoners mostly use criteria recommended by the WHO for population studies (WHO 2013): DMFT indicating the number of decayed teeth (D), missing and filled teeth due to dental caries (M, F), and Community Periodontal Index (CPI), which is used to assess periodontal health status and treatment need (Walsh et al. 2008). These indices are most often used to compare the findings within general populations. However, International Caries Detection and Assessment System (ICDAS) (Ismail et al. 2007) criteria have been developed to increase the validity and reliability of caries lesion detection.

Studies from other countries (McGrath 2002, Bansal et al. 2012, Akaji & Folaranmi 2013, Rodrigues et al. 2014) have indicated that prisoners’ oral health is poorer in comparison with non-prison individuals of same age group. In the above-mentioned studies, mean DMFT of the prisoners varies greatly, being the highest in China (23) and Brazil (20) and the lowest in Nigeria (2) and India (3 and 5). Prisoners have clearly more decayed (D) and missing (M) teeth, but fewer filled (F) teeth than general populations.

Periodontal status varies in the studies, mainly due to the differences in study methods and the indices used as well as demographic characteristics. When CPI index has been used, periodontitis (CPI >3) prevalence results varying from 40% to 77% have been reported in international prison studies (McGrath 2002, Heidari et al. 2007). In their recent study of Swedish male prisoners (n=186), Priwe C & Carlsson (2018) found a high prevalence of periodontal disease. Almost all (95%)
had signs of periodontitis and 66% had at least one tooth with a caries lesion requiring restorative treatment.

In addition to CPI, another commonly used index to assess periodontal status is Bleeding on Probing (BOP) score, which indicates visually evaluated gingival bleeding and is registered as highest BOP score for every eligible sextant. BOP is a prognostic indicator for future periodontitis (Joss et al. 1994). Other less commonly used periodontal indices used in prisoner studies are Loss of Attachment (LOA) score, Plaque Index (PI I) and Gingival Index (GI). Loss of attachment (LOA) score is an important measurement for periodontal disease severity (Joss et al. 1994). With PI I index, visible dental plaque is measured while gingival condition is evaluated with GI index (Löe & Silness 1963). The use of different indices as well as variation in age groups, gender and ethnicity in different studies makes comparison challenging.

For most prisoners, emergency care is the only dental service used both in civil life and during imprisonment. They visit the dental clinic only to get relief for pain or other dental problems (Freeman & Richards 2019).

### 2.3.2 Erosive tooth wear (ETW)

Erosive tooth wear refers to a chemical and mechanical process that results in the loss of hard dentinal tissue. No bacteria are involved; the phenomenon is caused by acidic oral environment (Carvalho et al. 2015). Uhlen et al. (2016) found that individual differences in the saliva and pellicle and in the enamel may also influence susceptibility to erosive wear. Therefore, in some individuals, even the smallest amount of acids can cause erosive tooth wear while others never develop erosion despite extensive exposure to acids.

ETW usually comprises the entire dentition, yet the severity varies in different sites. ETW lesions can be found on the occlusal, lingual/palatinal, buccal/facial as well as cervical part of the tooth surface. It rarely occurs in isolation but is commonly seen together with other types of tooth wear, such as attrition and abrasion. It is a phenomenon that is diagnosed visually rather than tactilely.

ETW has several background and risk factors and its aetiology is complex (Lussi & Carvalho 2014). The most common intrinsic factor for ETW is gastro-oesophageal disease, GERD, in which regurgitation of stomach contents into the oral cavity is continuous and persistent. Individuals with eating disorders with frequent vomiting, e.g. bulimia, are at risk of having ETW (Schlueter & Tveit 2014). Most often ETW is caused by acidic drinks and dietary products (Lussi Carvalho
The more continuously and more regularly these products are used, the greater the risk for ETW. Similarly, alcohol abuse is a risk for ETW; this is explained by simultaneous exposure to both intrinsic (GERD, vomiting) and extrinsic factors (alcohol consumption) (Teixeira et al. 2017). Saliva protects against ETW, but when saliva secretion is reduced, the risk for ETW increases. Some medicines, such as antihypertensive and antidepressants, reduce the salivary flow rate. Salas et al. (2015) showed in their meta-analysis that carbonated drinks, acid snacks/sweets, and naturally acidic fruit juices increased erosion.

Various indices have been used to measure and report ETW. The Basic Erosive Tooth Wear Examination (BEWE) index was mainly developed for general practitioners but is also suitable for research (Bartlett et al. 2008).

Depending on the diagnostic criteria, indices and thresholds used, the prevalence of ETW varies greatly, from 4 to 82% in adults. However, the prevalence of this condition is mostly high (Lussi & Carvalho 2014). In a middle-aged (44–46 years) Finnish population (n=1,962) the prevalence was 75% (Alaraudanjoki et al. 2016), while a study on young Europeans (18–35 years, n=3,187) revealed ETW prevalence of 29% (Bartlett et al. 2013). A recent study of Portuguese alcoholic patients (35–52 years of age, n=277) indicated 99% prevalence (Teixeira et al. 2017). All these studies used the BEWE index as a measure for ETW. To my knowledge, there are no studies on ETW of prisoners.

2.3.3 Temporomandibular disorders (TMD)

Temporomandibular disorders (TMD) is a term for dysfunctions, pain conditions and intra-articular clinical problems that can be applied to the temporomandibular joints, masticatory muscles, and closely associated structures (Okeson 2013). TMD symptoms and clinical findings are common in the population and the symptoms may vary from mild to disabling (Carlsson 1999). However, the symptoms and clinical findings are mostly mild and do not usually require treatment. The diagnosed need for TMD treatment is estimated to be 3–16% (Kuttila et al. 1998, Al-Jundi et al. 2008).

TMD has numerous and heterogeneous background factors, all may not be known, and the meanings and mechanisms of different components are still unclear (Okeson 2013). The symptoms are most common at the age of 20–40 years (Al-Jundi et al. 2008) and more common among women than men (Rutkiewicz et al. 2006). TMD can be associated with occlusal disorders (Jussila et al. 2019) and oral parafunctions, e.g. bruxism (Jiménez-Silva et al. 2017), although the relationship
of TMD with bruxism and occlusion is controversial. Psychological factors, such as stress, depression, anxiety, somatisation and personality traits, are associated with TMD (Manfredini et al. 2010, Nevalainen et al. 2016). Psychosocial factors influence, for example, the pain experience and response to treatment (Manfredini et al. 2010, Kotiranta et al. 201). In addition, trauma to the face and jaw area and to the cervical area expose to outbreak of TMD (Häggman-Henrikson et al. 2013).

TMD prevalence varies greatly, e.g. due to the diagnostic criteria and examination methods used and differences between study samples (De Kanter et al. 1993). In adult population, the prevalence of individual TMD symptoms has shown to vary from 5 to 50% while 40–90% of adults have clinical findings (Rutkiewicz et al. 2006).

Recently, the international scientific community developed a valid and consistent diagnostic set of criteria for TMD, the Diagnostic Criteria for Temporomandibular Disorders, DC/TMD, which are suitable for both clinical and research settings (Schiffman et al. 2014). The DC/TMD criteria (Dworkin & LeResche 1992; Schiffman et al. 2014). The Finnish version of DC/TMD was completed in 2016 (Ohrbach 2016).

The extensive research protocol in DC/TMD is divided into two axes: Axis I and Axis II. Axis I is a somatic part and includes valid diagnostic criteria in the most common pain diagnoses, i.e. myalgia, myofascial pain with referral, arthralgia, headache attributed to TMD, and intra-articular (joint) diagnoses, i.e. disk displacement (DD) with reduction, DD with reduction with intermittent locking, DD without reduction with limited opening, DD without reduction without limited opening, and degenerative joint disease. The Axis I sub-diagnoses are based on patient’s self-reported TMD symptoms (DC/TMD Symptom Questionnaire) and clinical examination. The DC/TMD clinical examination includes a systematic examination of the jaw movements, the palpation of masticatory muscles and temporomandibular joint (TMJ) areas as well as recording joint noises and movement pain. Axis II includes the assessment of factors related to pain chronicity and psychosocial background factors. Axis II helps in the assessment and treatment planning of TMD but does not enable making a diagnosis (Schiffman et al. 2014).

The use of psychoactive substances (smoking, alcohol, snuff and drugs) can associate with TMD. Daily smoking, the use of snuff and major alcohol consumption were found to increase the risk for nearly all TMD symptoms (Miettinen et al. 2017). Heroin and cocaine (Winocur et al. 2001), and especially bruxism-enhancing drugs such as ecstasy and methamphetamine (Maloney & Raymond 2014), increase parafunctional activities and TMD symptoms. Similarly,
methadone, used as a drug-related compensation medication, also exposes to bruxism (Enguelberg-Gabbay et al. 2016). Winocour et al. (2001) found an association between illicit drug use and TMD: drug addicts have more TMD signs and symptoms and oral motor parafunctions than non-drug users. To our knowledge, the prevalence of TMD has not been studied among prisoners so far.

2.3.4 Oral health-related behaviours

Studies on the most common factors associated with the prevalence of dental caries and periodontal diseases, e.g. dietary and tooth brushing habits, are scarce among prisoners. However, Heidari et al. 2014 concluded in their literature review that poor dietary habits and inadequate nutrition, high sucrose content of foods as well as poor oral hygiene habits contribute to prisoners’ risk of dental caries and periodontal disease. Nobile et al. (2007) concluded that Italian prisoners with a lower frequency of tooth brushing had poorer periodontal health in comparison with those who had better oral hygiene habits.

Studies on prisoners have reported overall poorer health and oral health in comparison with general population (Walsh et al. 2008). Substance abuse (smoking, use of snuff, drugs, and alcohol) has been shown to influence oral health problems in several ways (Heidari et al. 2014, Baghaie et al. 2017, Khairnar et al. 2017). For example, the use of illegal drugs decreases the pain threshold and may mask symptoms (Sheridan et al. 2001). Due to prisoners’ chaotic lifestyle with accidents and injuries, tooth fractures and losses are common (Viitanen et al. 2013). Irregular and acute dental visits do not favour good oral health. Prisoners have a high prevalence of communicable diseases HIV/AIDS, tuberculosis, sexually transmitted diseases, viral hepatitis, both B and C), together with mental illnesses and chronic diseases such as asthma, diabetes, and hypertension (Heidari et al. 2014, Moazen et al. 2018). All these diseases have an adverse effect on oral health.

Motivational interviewing (MI) is a simple, practical, and patient-centred method for engaging people in realising and finding solutions for their own problems (Miller & Rollnick 2013). According to motivational interviewing, every person is an expert on themselves and their own life, has the best solutions to their own problems, and has responsibility for how they live. In a supportive manner, a motivational interviewer encourages everyone to talk about their needs and their own life. The role of the interviewer is mainly to evoke a conversation. The person’s autonomy or right to self-determination is an important point in motivational interviewing (Kay et al. 2016). The basic communication skills used
in MI, known as reflective listening, consist of confirmation, open questions, reflections, and summaries (Miller & Rollnick 2013).

MI is well suited for dental care. It has been shown to work in caries prevention and it has a positive impact on absenteeism from dental visits (Martins & McNeil 2009, Gillam & Yusuf, 2019). This concept is well suited for interviewing prisoners even if the literature on the topic is scarce.

2.4 Dental and other fears

Dental fear/anxiety is a common specific fear all over the world, with prevalence varying from 4% to 83%. Dental fear is among the four most common fears (Oosterink et al. 2009). Fear is a natural and normal way to react for survival, an individual’s response to a known or definite danger or threat, whereas anxiety is a diffuse, unpleasant response to an imprecise or unknown threat which is not well defined. Fear is an immediate reaction to a threat or danger whilst anxiety is a reaction to non-immediate situations and is often accompanied by a sense of losing control (Armfield 2013). Phobia is a severe type of anxiety.

The aetiology of dental fear is complex and multifactorial (Beaton et al. 2014). Socio-demographic factors, such as female gender, young age and low education level are often associated with dental fear (Armfield et al. 2006, Svensson et al. 2016). Regular smoking has a positive correlation with dental fear (Pohjola et al. 2013). Adults with dental fear have reported having poor dental health in comparison with non-dentally fearful adults (Saatchi et al. 2015). The consequences of dental fear are irregular dental attendance or complete avoidance of dental care (Pohjola et al. 2007).

Measuring dental fear is important to understand patients’ reactions and to help them cope with the frightening situation. Various measurements and methods are used to assess different kinds and levels of dental fear. Dental Anxiety Scale (DAS) (Corah 1969) and Modified Dental Anxiety Scale (MDAS) (Humphris et al. 1995, Humphris et al. 2000) have been the most commonly and widely used dental anxiety measurements, estimating the level of overall dental anxiety and is a measure of trait anxiety describing anxiety as a general aspect of personality. The MDAS is a reliable and valid test with a five-item questionnaire to measure the respondent’s level of anxiety in specific dental situations: going to the dentist tomorrow, waiting in the dentist’s office for treatment, having tooth drilled, having tooth scaled and polished. A fifth and last question concerning fear of injection of local anaesthetic had been added to DAS and modified in MDAS. For each question,
there are five response alternatives, ranging from 1 (not anxious) to 5 (extremely anxious).

The Dental Visual Analogue Scale (DVAS) is a simple and rapid assessment tool for dental anxiety (Abend et al. 2014). It measures the severity of dental fear and is a measure of dental state anxiety (Luyk et al. 1998). The respondent’s current level of dental fear is marked on a 10 cm dotted line. There are 18 different dental procedures and situations to be considered. Dental fear can associate with many other specific fears, such as fear of heights, flying, closed spaces, animals, blood, and physical injuries (Oosterink et al. 2009). Among Danish adults (n=1,959), dental anxiety was ranked fourth among the ten most common anxiety disorders (Oosterink et al. 2009). Dental fear was positively correlated with depression and a variety of different psychiatric disorders (Locker et al. 2001) as well as with general fearfulness (Berggren 1992). General fearfulness can be measured with the Geer Fear Scale (GFS) form (Geer 1965, Berggren 1992). The GFS form contains 18 common fears. Moore et al. (1991) reported that patients with dental fear had two or more GFS scores of 6 or 7, and significant correlation existed between the GFS and the DAS. Berggren et al. (1992) found that half of the patients with severe dental fear had five or more severe general fears.
3 Aims of the study

The main aim of the study was to investigate and promote knowledge about oral health and associated factors among Finnish prisoners. This information can later be used to improve dental care among prisoners.

Our first hypothesis was that the oral health status of prisoners is poor, and generally poorer than among Finnish adult population. Furthermore, it was hypothesised that oral health-related behaviours are poor among prisoners. Secondly, it was hypothesised that the prevalence of dental fear is high among Finnish prisoners and prisoners with dental fear have poorer dental health than prisoners without dental fear. In addition, it was assumed that erosive tooth wear (ETW) is common among prisoners and association exists between ETW and the use of psychoactive substances, and between ETW and dental caries. Further, it was assumed that the prevalence of temporomandibular disorders (TMD) is high among prisoners.

The specific objectives of this research were:

1. To examine oral health and its association with oral health-related behaviours and dental fear among Finnish prisoners (Studies I and IV).
2. To assess the prevalence and severity of erosive tooth wear and its association with dental caries and the use of psychoactive substances among Finnish prisoners (Study II).
3. To evaluate the prevalence of self-reported TMD symptoms and clinically diagnosed TMD among Finnish prisoners and their associated factors (Study III)
4 Materials and methods

4.1 Study population

This work is composed of four individual studies. Data for the present study were collected at the Pelso Prison in Vaala, Finland, between September 2014 and February 2015. The examiner and the prison nurses, employees of the Criminal Sanctions Agency of Finland, informed all prisoners verbally about the purpose and approach of the study, inviting them to participate. The prisoners received a written information and consent form at their first visit. They all provided a written consent before entering the study.

The Pelso Prison is a closed prison with a capacity for 110 prisoners at a time, also during the field-phase of the study. The prison comprises an accommodation ward for females. Five prisoners refused to participate in the study. The reasons for non-participation were e.g. “Not having time for this” or “Not interested”. The prisoner’s sentences were not available for the research group, but the prisoners were remand, sentenced, fine defaulter or life sentence prisoners. However, there are more sentenced than remand prisoners in the Pelso Prison.

A total of 100 prisoners consented to this study; all were Finnish citizens and of Finnish origin. Over half of the prisoners (56%) came from northern or eastern Finland (Criminal Sanctions Agency 2018). The clinical examination was conducted on all volunteering prisoners. From the study population, the first 50 coming to the appointment were also interviewed face-to-face using motivational interviewing technique (convenience sample). The process and study population are shown in Fig.1.

The study population is the same in three studies (I, II, III). From study IV (dental fear), female prisoners were excluded due to their limited number (n=4).
Fig. 1. Examination scheme of the participants.

4.2 Clinical examination and study design (I, II, III, IV)

The clinical oral examinations included the assessment of dental and periodontal health, erosive tooth wear and temporomandibular disorders. The prison dentist (RV) performed the clinical examinations as well as clinical TMD examinations on all 100 study subjects. The examinations were carried out at the fully equipped dental clinic of Pelso Prison and normal infection control protocol was followed (THL 2016). The dental unit light, a three-in-one-syringe, a plain mouth mirror, a periodontal ball-pointed probe recommended by the World Health Organization (WHO), and fibre-optic transillumination (FOTI) device were used. When at least one caries lesion was clinically detected to extend into the dentin, bitewing radiographs (BW) were taken. The prison dentist analysed the radiographs and the information obtained from them was included in the clinical examination. No
professional cleaning was done before the examination because periodontal measuring was included in the clinical examination. A dental assistant registered all the findings in an individual electronic patient file system (Effica®, Tieto, Oulu, Finland). Information about the prisoners’ dental and periodontal status was recorded to form an electric database. Findings concerning erosive tooth wear (ETW), DC/TMD and dental fear were registered on structured forms and transferred later to the same database.

**Dental caries**

The International Caries Detection and Assessment System (ICDAS) (Ismail et al. 2007) criteria and activity estimation were used to record caries findings. Caries lesions were classified by the ICDAS protocol according to their appearance and were scored from 0 to 6. Estimation of lesion activity (+/-) was also included in examination. ICDAS Score zero (0) represents a sound surface, one (1) is a lesion visible after 5s blow-drying and two (2) is a visible enamel lesion. Three (3) is a lesion with demineralisation or loss of enamel substance, four (4) represents dentinal lesions visible under intact enamel, and five (5) dentinal cavities. Score six (6) is used for wide dentinal lesions covering more than half of the surface area. Lesions were categorised as follows: scores one (1) and two (2) and additionally inactive score three (3) comprised enamel lesions. Active score three (3) and scores 4–6 represented manifest caries lesions needing restorative treatment and active ICDAS 3 was the cut-off point for decayed lesion (D). In borderline cases, the worse alternative was chosen. The values of decayed (D), missing (M) and restored/filled (F) teeth and DMFT were calculated.

Caries detection was done before periodontal examination. Teeth were not professional cleaned but were clean enough for caries estimation.

**Periodontal health**

Periodontal health was examined as advised in the WHO criteria for epidemiological studies (WHO 2013). Periodontal health was visually inspected to detect the presence of plaque and calculus accumulation, after which all tooth surfaces (buccal, lingual, and interproximal surfaces) were probed with a WHO gingival probe using force of about 20 g. The weight was first calibrated in a training session using a digital letter scale and then periodically during the clinical examinations. Gingival bleeding was evaluated visually with an oral mirror and
registered as a BOP score/sextant with at least two teeth (yes/no). A sum score of the bleeding sextants was calculated. Calculus and the depth of periodontal pockets were registered for each sextant using Community Periodontal Index (CPI) (WHO 2013) (CPI was encoded using values from zero to four: 0 = healthy; 1 = bleeding observed; 2 = calculus detected during probing with periodontal pocket depth less than 4 mm; 3 = periodontal pocket depth of 4–5 mm; 4 = periodontal pocket depth of 6 mm or more in at least one tooth/sextant (WHO 2013). A full periodontal status with periodontal pockets and mobility measurements was presented if CPI ≥ 4. For the analyses, CPI values were classified into two groups: “high” (3 or 4), and “low” values (0-2).

**Erosive tooth wear (ETW)**

Erosive tooth wear was measured using the BEWE index (Bartlett et al. 2008). All teeth in all six sextants were assessed for erosive wear and categorised according to the BEWE scoring system (range 0–3). The score for each sextant was recorded if there were two or more teeth present. Score 0 = no erosive tooth wear; 1 = initial signs of erosive tooth wear; 2 = distinct defect, hard tissue loss less than 50% of the tooth surface, and 3 = hard tissue loss, over 50% of the surface. If extensive restorations covered the entire tooth surface, scoring could not be done. The highest score for each of the six sextants was determined and the total sum was calculated. The sum scores ranged from 0 to 18 and were categorised into three classes: sum score 0–2 indicating no or mild erosive tooth wear and no treatment need, sum scores 3–8 indicating moderate erosive tooth wear and treatment need, and sum scores 9–18 indicating severe erosive tooth wear and treatment need.

**Temporomandibular disorders (TMD)**

The clinical examination of TMD was done according to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I diagnostic criteria (Schiffman et al. 2014, Ohrbach 2016). The used Finnish version of the DC/TMD was a pre-final version. The clinical TMD diagnoses were acquired according to the diagnostic algorithms for DC/TMD sub-diagnoses.
Calibration of the clinical examinations

One examiner (RV) performed all the clinical examinations. The examiner was trained in the study protocol and diagnostic criteria by clinical training. Specialists and senior researchers in cariology (VA), public dental health (MLL) and prosthetic dentistry and stomatognathic physiology (KS) provided the training. Extracted teeth that had been cut into halves were used to demonstrate the different stages of dental caries (ICDAS). Following the training, five voluntary prisoners were invited to clinical examination (dental caries, periodontal status, ETW) to pilot the protocol, demonstrate the clinical examinations, and for calibration. These volunteers were included in the study population. The piloting was performed by the examiner together with the experienced clinicians and senior researchers (VA and MLL). In the research team, MLL also acted as the gold standard. The calibration for TMD was performed against a reference standard examiner accredited by the DC/TMD Training and Calibration Centre at Malmö University, Malmö, Sweden (KS).

To assure the reliability of the clinical findings, the intra-examiner and inter-examiner agreements were investigated for dental caries (ICDAS) and ETW and TMD by calculating kappa values (κ). To ensure inter-examiner agreement, the examiner and the gold standard re-examined ten prisoners for caries and erosive tooth wear on three occasions two months apart. Similarly, every 10th prisoner was re-examined by the examiner about one month after the first examination to ensure intra-examiner agreement. As for TMD clinical examination, the examiner and the reference standard examiner re-examined a total of 13 prisoners on two occasions about two months apart.

The kappa values were categorized as follows: > 0.75 excellent reliability, 0.40–0.75 fair to good reliability, and < 0.40 poor reliability (Fleiss JL et al. 2003). The intra-examiner agreement for ICDAS (κ = 0.79) and for BEWE (κ = 0.81) was excellent, as was the inter-examiner agreement for ICDAS (κ = 0.82) and for BEWE (κ = 0.82). Kappa values for all but one of the TMD pain-related Axis I diagnoses were excellent (arthralgia κ = 1.00, headache attributed to TMD κ = 1.00, myalgia κ = 0.81), and for myofascial pain κ was 0.41, indicating fair inter-examiner reliability. More variability was found for joint-related diagnoses. The inter-examiner reliability was 100% for the diagnoses DD with reduction with intermittent locking and DD without reduction with limited opening. Reliability was excellent for the diagnosis DD without reduction without limited opening. κ
values were fair to good for DD with reduction ($\kappa = 0.49$) and degenerative joint disease ($\kappa = 0.58$).

4.3 Questionnaires and interviews

The questionnaire consisted of four parts: socio-demographic background factors, health-related and oral health-related behaviours, dental and other fears, and TMD symptoms. Motivational interviewing technique was used to complete all questionnaires and the examiner took general notes during the session. This technique comprised creating accepting atmosphere, open questions without possibility to answer yes or no, listening, reflection and conclusion (Miller & Rollnick, 2013). All the questionnaires except for the Finnish DC/TMD Symptom Questionnaire were filled in a separate appointment in the prison’s dental office following the clinical examination. The participants were given a chance to fill in the forms of dental fear themselves but if necessary, the examiner assisted the respondents. Each interview took about 90 minutes.

4.3.1 Socio-demographic background factors

The socio-demographic factors used in the present study were age, gender, level of education, and marital status. For the analyses, prisoners’ personal identity numbers were deleted, and they were assigned an ID number (1–100). Information on education and marital status was elicited in the interview when filling in the questionnaire. Marital status was classified as married or cohabiting and single, which included the options widow or divorced. Prisoners reported the attained level of their education with the options: no education / compulsory basic education of nine years / vocational school / matriculation exam or gymnasium / college / university of applied sciences / university / other. For the analyses, these were dichotomised as follows: compulsory education of nine years and vocational school or gymnasium (matriculation examination and gymnasium).

4.3.2 Health and oral health behaviours

The questionnaire (Anttonen et al. 2012) comprised questions on health behaviours and oral health-related habits as well as use of psychoactive substances (Appendix).

Oral hygiene and dietary habits were asked in the interview. “How often do you brush your teeth?” the options being never or hardly ever / every day or almost
every day / now and then during the week. Those who reported brushing their teeth
every day were also asked: “How many times do you brush your teeth?” with
options: once a day / twice a day / more than twice a day. For the analyses, these
were dichotomized as follows: brushing once a day and two times per day (twice a
day and more than twice a day). The use of dental floss and interdental brush and
toothpicks was surveyed with the question “Do you use dental floss or interdental
brush or toothpicks, the options being never or hardly ever / every day or nearly
every day / now and then during the week. Eating sweets and drinking fizzy drinks
was surveyed with the questions “How often do you eat sweets / drink fizzy drinks?”
with options never or hardly ever / every day or almost every day / occasionally
during the week). There were also questions about received guidance on individual
oral hygiene and dietary counselling as well as received orthodontic treatment. In
addition, questions concerning dental attendance were surveyed with the question
“How often do you visit a dentist?” with response alternatives only when I have
pain or other problems / regularly for check-ups / never. Assessment of the need of
dental care (yes / no), the presence of tooth symptoms or toothache (yes / no) and
toothache caused by drinking or acidic food and toothache due to temperature
variation (cold / hot) were asked.

The questions on the use of snuff, use of drugs and use of alcohol concerned
the use in civil life before the imprisonment. Use of snuff and drugs was asked with
yes / no options. Alcohol consumption was asked with the options no / twice a
month or less frequently / once a month / every other week / about once a week /
more than once a week. In the analyses, alcohol users were divided into three
groups: sober ones (who answered no), moderate consumers, and major consumers
(who used alcohol more than once a week). Current smoking was surveyed with
the question “Do you smoke?” no / 1–20 cigarettes daily / more than 20 cigarettes
daily. The study population was categorised into three groups: non-smokers,
smokers (1–20 cigarettes daily) and heavy smokers (more than 20 cigarettes daily).
In addition, the participants were asked at what age the substance (smoking, use of
snuff, alcohol and drug) use had begun.

4.3.3 TMD symptoms

The DC/TMD Symptom Questionnaire (http://www.rdc-tmdinternational.org) was
filled in and the clinical examination of TMD conducted at the same appointment.
The questionnaire inquired about the presence of TMD symptoms during the past
30 days using the Finnish version of the DC/TMD Symptom Questionnaire
(Ohrbach 2016). When necessary, the examiner assisted with a face-to-face interview.

4.3.4 Dental fear and general fears

The term “dental fear” related to dental treatment used here covers dental fear, dental anxiety and severe dental fear, even though these concepts are not the same. Forty-six male participants comprised the material for the fear analyses. The prisoners’ dental and other general fears were surveyed with three different fear forms (Geer 1965, Luyk et al. 1988, Humphris et al. 1995). With the Modified Dental Anxiety Scale (MDAS) validated form, the level of overall dental fear/anxiety was surveyed (Humphris et al. 1995). The MDAS form contains five multiple-choice questions associated with the level of anxiety in specific dental situations: waiting for dental treatment, drilling, scale and polish, and local anaesthesia. The respondents rate their dental anxiety level with alternatives ranging from not anxious at all (1) to extremely anxious (5). The total sum of these five questions provides the level of dental anxiety. Five is the minimum score and 25 the maximum. MDAS scores were classified into three categories: scoring 5–9, the respondent was considered not at all anxious, scores 10–18 meant the subject was moderately anxious, while score 19 or more was categorised as dentally extremely anxious. Scores were also dichotomised into two: < 10 (no dental fear at all) and ≥ 10 (at least some degree of dental fear).

The Dental Visual Analogue Scale (DVAS) form estimates the severity of dental fear in terms of 18 different dental procedures and situations (Luyk et al. 1988). Respondent’s current level of dental fear for 18 different procedures and situations is marked on a 10 cm dotted line. At the other end of the line, score 0 indicates no fear at all and at the other end, score 10 indicates the worst imaginable fear. These 18 procedures and situations are: visiting a dentist, pain in general, injection needle for local analgesics, ‘squeaking’ sounds, drilling with vibrating drill, drilling with ‘squeaking’ drill, inspecting teeth with metal instruments, removal of dental calculus, scolding expressed by dentist, saliva suction, tooth extraction, taking an x-ray, holding mouth open for a long time, drying tooth with air blow, measurement of gingival pockets, applying filling material, root canal preparation, multiple instruments simultaneously in mouth. Both MDAS and DVAS were included because MDAS is a measure of trait dental anxiety and DVAS is a measure of dental state anxiety.
In addition, the prisoners were requested to fill out a Geer Fear Scale (GFS) form with questions regarding the presence or absence of 18 common fears (fear of sharp objects, worms, rats and mice, injections, spiders, blood, heights, enclosed spaces, thunder, snakes, cemeteries, dark places, strange dogs, biting insects, car accidents, public situations, open places, and other people) and asked to estimate their degree of fear on a 7-point scale: 1 = not at all, 2 = very little, 3 = a little, 4 = to some extent, 5 = a lot, 6 = very much and 7 = horrified.

The prisoners completed the DVAS and GFS forms assisted whereas other forms were manually filled in by the examiner. The prisoners’ own opinions on the underlying factors of dental fear were asked with the questions: “In your opinion, what are the reasons for your dental fear?” painful or difficult experiences of previous dental care / bad experiences of the dental fear of your relatives or friends / extensive treatment need / general health or psychological problems / poor behaviour by dental personnel. The respondents were asked whether nitrogen oxygen or conscious oral sedation had been used previously for dental fear (yes / no).

4.4 Data from patients’ records

The date of birth and gender of the prisoners as well as medicines used were obtained from prisoners’ patient records. Prescribed medication was categorised as antipsychotics / analgesics / sleeping and falling asleep / insomnia medications / asthma / allergy / cardiovascular medication as well as drug-related compensation medication. Likewise, information about viral hepatitis and HIV infection was obtained in the patient records.

4.5 Statistical considerations

In all studies, statistical analyses were performed using the SPSS (version 22.0 or 24.0, SPSS Inc., Chicago, IL; USA). Statistical significance level was set at \( p \) lower than 0.05 in all studies.

Dental health (I, II, IV)

The study material in terms D, M, F, T, DMFT, BOP sum, CPI mean values and sociodemographic as well as the use of psychoactive substances was described as frequencies and distributions of mean and standard deviation values. The D, M, F
and T values as well as DMFT values were dichotomised according to the distribution of these values in the study sample. D was dichotomised as <5 and ≥5, the M values as <6 and ≥6, the F values as <7 and ≥7, the T values <24 and ≥24 and the DMFT values as <16 and ≥16. Restorative (ICDAS ≥+3 = D) and periodontal (CPI ≥2) treatment need were outcome variables. Because of the skewness of the data in study IV (n=46), dental health was recorded as frequencies and median values (min, max) of D, M, F and T.

For statistical analyses, participants were dichotomised into yes/no groups according to whether they smoked or not. As for alcohol consumption, participants were categorised into three groups: sober ones (no), moderate consumers (twice a month or less frequently; once a month; every other week; once a week) and major consumers (more than once a week).

**Dental fear (IV)**

The mean values (SD) for MDAS, DVAS and GFS were calculated. The MDAS scores were dichotomised for the statistical analyses, first to three sub-groups and then two groups: no dental fear at all (MDAS <10) or at least some degree of dental fear (≥10). The GFS scores were dichotomised considering the small subgroups: no fear at all or little fear (scores 1 to 3) and fear to some extent to being horrified (scores 4 to 7). Dental attendance was divided into regular attendance and irregular attendance, which contained the alternatives emergency and never. For prescribed medications, cut-off point 4 or more medicines was used.

The significance of the association between variables was analysed by using cross tabulation with Pearson’s Chi-square or Fisher’s tests. A stepwise logistic regression model was accomplished by excluding variables from the model one by one on the grounds of their p-values. Severe dental fear was the dependent variable while age, education level, DMFT, smoking, the use of snuff and alcohol or drugs as well as prescribed medications and dental attendance were explanatory variables. The results were described as odds ratio (OR) and 95% confidence intervals. The independent samples Kruskall-Wallis test was used to compare differences between MDAS categories and D, M, F and T and DMFT.

**ETW (II)**

The highest BEWE scores (range 0 to 3) per prisoner were recorded and distribution was presented.
Cross tabulation with Pearson’s Chi-square or Fisher’s exact tests considering the age of the participants with 35 years as a cut-off point was used to analyse the association between ETW and dental caries, use of psychoactive substances and use of pharmaceuticals. In further analysis, the odds ratios (OR) and their 95% confidence intervals (CI) were calculated using the logistic regression model. The exclusion of the variables was made on the grounds of their significance.

**DC/TMD (III)**

Due to the limited number of female prisoners, the data of both genders were combined for TMD analyses. Self-reported TMD symptoms and sub-diagnoses were described as proportions and frequencies. The study sample was dichotomized by age (<35 years vs. ≥35 years) according to the distribution of age in the study population.

The significance of the association between TMD symptoms and sub-diagnoses and age was analysed by using cross tabulation with Pearson’s Chi-square or Fishers’ exact tests.

### 4.6 Ethical considerations

The research plan was evaluated by the Ethical Committee of the Northern Ostrobothnia Hospital District and permission was given on 16 June 2014 (EETTMK: 50/2014, 16 June 2014). The Finnish Criminal Sanctions Agency gave a positive statement on the present study on 8th August 2014.

All the prisoners at the Pelso Prison were given an opportunity to participate voluntarily in the study. Refusal was possible at any stage of the study. All participants were informed about their oral health and the dental care they needed. If the participants consented, they would receive all dental care free of charge. All the participants gave their informed consent. The author was unaware of the prisoners’ convictions. Anonymity of the participants was ensured at all stages of the study and data were used only for this research.
5 Results

5.1 Study population

Males (89%) dominated the study population while there were 11 females (11%). The mean age was 35 years (min 21 years, max 70 years) for males and 38 years (min 21 years, max 60 years) for females. One third of the study sample subjects were younger than 30 years of age.

Two thirds of the prisoners were single. The educational status was low as 63% of the men reported that they had completed only the compulsory nine-year school education. Only two (4%) of the male prisoners had accomplished the matriculation examination; the rest (33%) had vocational school education. All the female participants had only compulsory nine years’ education.

5.2 Oral health (I)

Four fifths (81%) of the prisoners needed restorative treatment (ICDAS score ≥active 3 = D). None were edentulous; the mean number of teeth was 24.3 (SD 6.57), the range 5 to 32 teeth. The mean value of D was 5.0 (SD 5.11), M (no wisdom teeth included) 5.0 (SD 6.19), F 6.9 (SD 5.15), and DMFT 16.8 (SD 8.86), in the entire study population (n=100). Older prisoners (≥35 years) had higher DMFT values than younger ones (<35 years) (p = 0.001). Even though almost all reported brushing their teeth daily nearly all (92%) had need of periodontal treatment (CPI ≥2). When comparing CPI values, older prisoners had significantly more frequently values 3 or 4 than younger ones (p = 0.001). Seven prisoners (7%) (all ≥35 years) had CPI value 4. As for BOP, the proportion of those with all sextants bleeding was 71%.

5.3 Erosive tooth wear (II)

The prevalence of ETW among Finnish prisoners was high (90%), indicating at least moderate tooth wear (BEWE sum score ≥3) and need for preventive and operative care. Ten per cent of the respondents had BEWE sum score 0–2, 71% had BEWE sum score 3–8, and one fifth (19%) had severe erosive tooth wear (BEWE sum score 9–18) (Table 1). Among interviewed participants (n=50) with severe ETW (n=11), five participants (46%) were major alcohol consumers.
Table 1. Prevalence of erosive tooth wear according to the sum scores of BEWE among the study population (n=100).

<table>
<thead>
<tr>
<th>BEWE sum score</th>
<th>Frequency n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1 (1.0)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3 (3.0)</td>
<td>10 (10.0) (mild/no)</td>
</tr>
<tr>
<td>2</td>
<td>6 (6.0)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4 (4.0)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4 (4.0)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9 (9.0)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>32 (32.0)</td>
<td>71 (71.0) (moderate)</td>
</tr>
<tr>
<td>7</td>
<td>8 (8.0)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>14 (14.0)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>4 (4.0)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>4 (4.0)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1 (1.0)</td>
<td>19 (19.0) (severe)</td>
</tr>
<tr>
<td>12</td>
<td>10 (10.0)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100 (100.0)</td>
<td>100 (100.0)</td>
</tr>
</tbody>
</table>

5.4 Temporomandibular disorders (TMD) (III)

The prevalence of TMD symptoms was high: 84% of the respondents reported having one or more TMD symptoms. Facial pain was the most common symptom (54%), followed by joint noises (43%), and headache (37%). One or more TMD sub-diagnoses were found in 60% of the participants. The most common diagnoses for TMD were disc displacement (DD) with reduction (33%) and degenerative joint disease (33%) (Table 2). The prevalence of joint-related diagnoses was 4.5-fold (76% vs. 17%) compared to diagnoses attributed to TMD pain. There were no cases of DD without reduction with limited opening. Differences between age groups or gender were not statistically significant.
Table 2. Prevalence of self-reported temporomandibular disorder (TMD) symptoms and sub-diagnoses of TMD among Finnish prisoners by age group (n=100).

<table>
<thead>
<tr>
<th>Variables</th>
<th>&lt;35 years</th>
<th>≥ 35 years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Symptom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facial pain</td>
<td>31 (58.5)</td>
<td>23 (48.9)</td>
<td>54 (54.0)</td>
</tr>
<tr>
<td>Joint noises</td>
<td>26 (49.1)</td>
<td>17 (36.2)</td>
<td>37 (37.0)</td>
</tr>
<tr>
<td>Headache</td>
<td>21 (39.6)</td>
<td>16 (34.0)</td>
<td>43 (43.0)</td>
</tr>
<tr>
<td>Jaw locking</td>
<td>4 (7.5)</td>
<td>3 (6.4)</td>
<td>7 (7.0)</td>
</tr>
<tr>
<td>Diagnoses attributed to pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myalgia</td>
<td>4 (7.6)</td>
<td>3 (6.4)</td>
<td>7 (7.0)</td>
</tr>
<tr>
<td>Myofascial pain with referral</td>
<td>3 (5.7)</td>
<td>1 (2.1)</td>
<td>4 (4.0)</td>
</tr>
<tr>
<td>Arthralgia</td>
<td>2 (3.8)</td>
<td>2 (4.3)</td>
<td>4 (4.0)</td>
</tr>
<tr>
<td>Headache attributed to TMD</td>
<td>1 (1.9)</td>
<td>1 (2.1)</td>
<td>2 (2.0)</td>
</tr>
<tr>
<td>Temporomandibular joint diagnoses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DD with reduction</td>
<td>17 (32.1)</td>
<td>16 (34.0)</td>
<td>33 (33.0)</td>
</tr>
<tr>
<td>DD with reduction with intermitting locking</td>
<td>1 (1.9)</td>
<td>0</td>
<td>1 (1.9)</td>
</tr>
<tr>
<td>DD without reduction without limited opening</td>
<td>5 (9.4)</td>
<td>4 (8.5)</td>
<td>9 (9.0)</td>
</tr>
<tr>
<td>Degenerative joint disease</td>
<td>20 (37.7)</td>
<td>13 (27.7)</td>
<td>33 (33.0)</td>
</tr>
</tbody>
</table>

DD = disc displacement

5.5 Medications and substance use (I, II, III, IV)

5.5.1 Prevalence of use of psychoactive substances (I, II, III, IV)

Almost all participants (88%) reported smoking daily. Of the smokers, every third (36%) was a heavy smoker smoking more than 20 cigarettes daily. Snuff use was less common, but as many as 20% had used snuff daily in civil life. All the snuff users smoked, and almost all of them (9/10) had used drugs. Before imprisonment, alcohol had been used by the majority (72%); of those, one third (33%) were major alcohol consumers, consuming alcohol more than once a week. History of drug use was even more common than major alcohol consumption: 62% reported having used illegal drugs in civil life before imprisonment. Younger prisoners (<35 years) smoked and had consumed alcohol significantly more often than older ones. The average age for starting smoking and consuming alcohol was lower than the onset age for starting the use of drugs and snuff. (Table 3). Six male prisoners smoked and used snuff, alcohol and drugs.
Table 3. Use of psychoactive substances among Finnish prisoners according to age, n=50.

<table>
<thead>
<tr>
<th>Substance</th>
<th>&lt;35 years</th>
<th>≥35 years</th>
<th>Total</th>
<th>p-value*</th>
<th>Average age for onset</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tobacco</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>29 (65.9)</td>
<td>15 (34.1)</td>
<td>44 (88.0)</td>
<td>0.003*</td>
<td>14 years</td>
</tr>
<tr>
<td>no</td>
<td>0</td>
<td>6 (100.0)</td>
<td>6 (12.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>25 (69.4)</td>
<td>11 (30.6)</td>
<td>36 (72.0)</td>
<td>0.009*</td>
<td>15 years</td>
</tr>
<tr>
<td>no</td>
<td>4 (25.6)</td>
<td>10 (71.4)</td>
<td>14 (28.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snuff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>8 (80.0)</td>
<td>2 (20.0)</td>
<td>10 (20.0)</td>
<td>0.160</td>
<td>16 years</td>
</tr>
<tr>
<td>no</td>
<td>21 (52.5)</td>
<td>19 (47.5)</td>
<td>40 (80.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>21 (67.7)</td>
<td>10 (32.3)</td>
<td>31 (62.0)</td>
<td>0.075</td>
<td>18 years</td>
</tr>
<tr>
<td>no</td>
<td>8 (42.1)</td>
<td>11 (57.9)</td>
<td>19 (38.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Chi-Square
5.5.2 Prescribed medications, viral hepatitis and HIV infections (II, III, IV)

Use of prescribed medicines was common and almost everyone (87%) had at least one medication while the proportion of those with four or more medications was 28%. The most common medications were antipsychotics, painkillers and medicines for insomnia. More than half of the subjects (56%) had hepatitis C; 8 of 11 females and 48 of 89 males. None were reported to have HIV infection.

5.6 Prevalence of dental and general fear (IV)

Of the participants, 8.7% had severe dental fear (MDAS ≥19), while the proportion of those with mild or no dental fear at all (MDAS <10) was 60.9%. Mean MDAS was 10.2 (SD 5.61) indicating moderate dental fear. Participants with only nine years’ compulsory education had higher mean scores for dental anxiety (MDAS ≥10) than the rest (48.0% vs. 28.6%), but the difference between the groups according to the education attained was not significant. Snuff users reported dental fear more often than those not using snuff ($p = 0.033$). Prisoners having severe dental fear ($n=4$, MDAS ≥19) smoked and had more teeth and attended emergency dental care more often than the rest. All non-smokers had low MDAS scores (5–7).

Among the male prisoners, the most fear-inducing dental procedure was tooth extraction (DVAS mean 4.2; SD 3.93), followed by root canal treatment (3.7; 3.52) and pain in general (3.6; 2.88). Other frightening items were drilling, situations where there were several instruments in the mouth simultaneously, and injection needles for local analgesics. Taking a dental radiograph was the least frightening dental procedure. (Table 4).

The most common general fear among the participants was fear of heights, the second most common was fear of public situations, followed by car accidents and injections (Fig 2.). Sixteen male prisoners (32%) reported having at least one general fear with scores 6 and/or 7 (very much fear, horrified), and five (10%) of them had also severe dental fear (MDAS ≥19). Two prisoners reported having no general fears (total GFS score 18), no dental fear (MDAS 5) and they had marked zero on all DVAS lines. Mean values for fear of injection needle in local anaesthesia (DVAS mean 2.6; SD 2.97) and general fear for injections (GFS mean 2.4; SD 1.74) were similar. Dentally fearful prisoners (MDAS ≥10) also feared sharp objects ($p = 0.018$), spiders ($p = 0.000$), blood ($p = 0.054$), snakes ($p = 0.042$) and open places ($p = 0.054$) more than those without dental fear (MDAS <10).
According to the prisoners with dental fear (MDAS \( \geq 10 \), \( n=18 \)) the most common cause for their dental fear was previous painful or difficult experience (12 out of 18, 67%). Other reported causes included previous extensive dental treatments (5 out of 18, 28%) and attitude by dental personnel (2 out of 18, 11%), as well as indirect causes such as stories of poor dental experiences by relatives or friends (2 out of 18, 11%). Two participants reported general health problems as the cause for dental fear.

Seven respondents reported having never visited a dentist, but three of them still reported having dental fear (MDAS \( \geq 10 \)). In only a few cases, general anaesthesia (\( n=1, 2.2\% \)), nitrogen oxygen (\( n=1, 2.2\% \)) and conscious oral sedation (\( n=4, 8.7\% \)) had been used previously because of dental fear.

![Fig. 2. General Fears according to Geer fear scale (GFS) among Finnish male prisoners, \( (n=46) \)](image-url)
Table 4. Self-reported dental fear caused by different dental procedures (mean values and standard deviations (SD)) measured with Dental Visual Analogue Scale (DVAS, x/10cm) among Finnish male prisoners, n=46.

<table>
<thead>
<tr>
<th>Dental procedure</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tooth extraction</td>
<td>4.2</td>
<td>3.93</td>
</tr>
<tr>
<td>Root canal preparation</td>
<td>3.7</td>
<td>3.52</td>
</tr>
<tr>
<td>Pain in general</td>
<td>3.6</td>
<td>2.88</td>
</tr>
<tr>
<td>Drilling with a ‘squeaky’ drill</td>
<td>3.1</td>
<td>3.10</td>
</tr>
<tr>
<td>Drilling with a vibrating drill</td>
<td>2.9</td>
<td>3.10</td>
</tr>
<tr>
<td>Multiple instruments in mouth</td>
<td>2.7</td>
<td>2.85</td>
</tr>
<tr>
<td>Injection needle</td>
<td>2.6</td>
<td>2.97</td>
</tr>
<tr>
<td>Squeaky sounds</td>
<td>2.2</td>
<td>2.53</td>
</tr>
<tr>
<td>Visiting dental clinic</td>
<td>2.0</td>
<td>2.70</td>
</tr>
<tr>
<td>Inspecting teeth with metal instruments</td>
<td>2.0</td>
<td>2.43</td>
</tr>
<tr>
<td>Removal of dental calculus</td>
<td>1.6</td>
<td>1.82</td>
</tr>
<tr>
<td>Scolding by the dentist</td>
<td>1.4</td>
<td>2.15</td>
</tr>
<tr>
<td>Holding mouth open a long time</td>
<td>1.2</td>
<td>1.95</td>
</tr>
<tr>
<td>Drying tooth with air blow</td>
<td>0.8</td>
<td>1.22</td>
</tr>
<tr>
<td>Measuring of gingival pockets</td>
<td>0.7</td>
<td>1.26</td>
</tr>
<tr>
<td>Saliva suction</td>
<td>0.7</td>
<td>0.96</td>
</tr>
<tr>
<td>Applying of filling material</td>
<td>0.6</td>
<td>0.91</td>
</tr>
<tr>
<td>Taking an x-ray</td>
<td>0.5</td>
<td>1.28</td>
</tr>
</tbody>
</table>

5.7 Oral health and associated factors

5.7.1 Sociodemographic factors (I)

Older prisoners (≥35 years) had had more previous dental care due to dental caries (M,F) than younger ones (p = 0.001), whereas present restorative treatment need (D) was similar in both groups. Gender or education was not associated with the mean D, F, M or DMFT values.

5.7.2 Oral health-related behaviours (I, IV)

Those who used to visit dental care regularly in civil life had significantly better periodontal status according to BOP sum (p = 0.045). All but one reported brushing their teeth every day, nearly half (46%) reported brushing twice or more often daily. Three prisoners used dental floss daily, whereas toothpicks and interdental brushes were used more frequently: 64% reported using them every day or at least now and
then during the week. However, none of the prisoners had healthy periodontal tissues (CPI value 0). Those reporting eating sweets never or hardly ever had more present and past caries experience (DMFT) than the rest ($p = 0.029$) (Table 5).

### 5.7.3 Use of psychoactive substances (III, IV)

Non-smokers had less caries treatment need (not significant) and had significantly more filled/restored teeth than smokers ($p<0.001$). When comparing alcohol consumers, the sober ones had more teeth ($p = 0.016$) as well as fewer missing teeth ($p = 0.020$) than alcohol consumers. The prisoners using snuff had less restorations ($p = 0.004$) compared to the non-snuffers. Drug users had less filled teeth ($p = 0.011$) than non-drug users (Table 6).

### 5.7.4 Association of dental caries with ETW (II)

The number of filled teeth ($F$) and ETW was statistically significantly associated ($p = 0.038$). There was a tendency to an increased risk for ETW among the major alcohol consumers (OR 4.3, 95%CI 0.93–19.44) and older prisoners ($\geq 35$ years) (OR 3.5, 95% CI 0.8–15.13).

### 5.7.5 Factors associated with TMD (III)

No association was found between dental caries, periodontal disease or ETW and TMD. Neither was there an association between missing teeth and TMD. No significant associations were found between TMD diagnoses and the use of psychoactive substances.

### 5.7.6 Association of oral health with dental fear (IV)

Prisoners with mild or no dental fear (MDAS <10) had on average more filled teeth ($F$) than those with moderate or severe dental fear (MDAS $\geq 10$) ($p = 0.008$. In addition, those who reported dental fear (MDAS $\geq 10$) also reported less frequent dental attendance than the rest ($p = 0.015$).
Table 5. The mean and standard deviations (SD) of D, DMFT, CPI, BOP sum, BEWE sum according to age, gender, education, marital status, dental attendance, brushing habits, and use of sweets, and fizzy drinks among Finnish prisoners, n=50.

<table>
<thead>
<tr>
<th>Variable</th>
<th>n (%)</th>
<th>D (mean (SD))</th>
<th>DMFT (mean (SD))</th>
<th>CPI (mean (SD))</th>
<th>BOP sum (mean (SD))</th>
<th>BEWE sum (mean (SD))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>&lt;35</td>
<td>29(58.0)</td>
<td>5.0 (5.94)</td>
<td>15.1 (8.99)</td>
<td>2.1 (0.68)</td>
<td>5.0 (1.78)</td>
<td>6.4 (2.28)</td>
</tr>
<tr>
<td>≥35</td>
<td>21(42.0)</td>
<td>4.7 (4.06)</td>
<td>21.3 (8.00)*</td>
<td>2.2 (0.98)</td>
<td>4.8 (1.87)</td>
<td>7.7 (2.43)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4(8.0)</td>
<td>4.3 (3.30)</td>
<td>16.0 (8.37)</td>
<td>2.5 (1.29)</td>
<td>5.8 (0.50)</td>
<td>8.0 (2.16)</td>
</tr>
<tr>
<td>Male</td>
<td>46(92.0)</td>
<td>5.0 (5.35)</td>
<td>17.9 (9.17)</td>
<td>2.1 (0.78)</td>
<td>4.9 (1.86)</td>
<td>6.9 (2.43)</td>
</tr>
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<td>Education</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compulsory</td>
<td>33(66.0)</td>
<td>5.2 (5.37)</td>
<td>17.7 (9.07)</td>
<td>2.2 (0.82)</td>
<td>4.9 (1.75)</td>
<td>6.9 (2.69)</td>
</tr>
<tr>
<td>Gymnasium</td>
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<td>4.3 (4.93)</td>
<td>17.7 (9.37)</td>
<td>2.1 (0.82)</td>
<td>5.1 (1.95)</td>
<td>7.1 (1.80)</td>
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<tr>
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<tr>
<td>Married</td>
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<td>5.4 (4.26)</td>
<td>19.8 (9.03)</td>
<td>2.3 (0.81)</td>
<td>5.0 (1.73)</td>
<td>6.6 (2.92)</td>
</tr>
<tr>
<td>Single</td>
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<td>4.6 (5.66)</td>
<td>16.6 (9.99)</td>
<td>2.1 (0.81)</td>
<td>4.9 (1.87)</td>
<td>7.2 (2.12)</td>
</tr>
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<td>Dental attendance</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Regular</td>
<td>8 (16.0)</td>
<td>2.8 (1.83)</td>
<td>21.0 (5.86)</td>
<td>2.0 (0.78)</td>
<td>4.0 (2.41)</td>
<td>7.4 (3.54)</td>
</tr>
<tr>
<td>Irregular</td>
<td>42(84.0)</td>
<td>5.3 (5.53)</td>
<td>17.1 (9.45)</td>
<td>2.2 (0.83)</td>
<td>5.1 (1.71)*</td>
<td>6.9 (2.18)</td>
</tr>
<tr>
<td>Brushing</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x daily</td>
<td>23 (46.0)</td>
<td>4.4 (4.00)</td>
<td>18.1 (8.61)</td>
<td>2.4 (0.83)</td>
<td>5.0 (1.76)</td>
<td>6.7 (2.44)</td>
</tr>
<tr>
<td>once a day</td>
<td>27(54.0)</td>
<td>5.3 (6.08)</td>
<td>17.3 (9.54)</td>
<td>2.0 (0.76)</td>
<td>4.9 (1.88)</td>
<td>7.2 (2.40)</td>
</tr>
<tr>
<td>Sweets</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>every day</td>
<td>30 (60.0)</td>
<td>4.9 (5.78)</td>
<td>15.4 (8.69)</td>
<td>2.4 (0.82)</td>
<td>5.1 (1.65)</td>
<td>7.1 (2.10)</td>
</tr>
<tr>
<td>never</td>
<td>20 (40.0)</td>
<td>4.9 (4.30)</td>
<td>21.1 (8.68)*</td>
<td>2.4 (0.81)</td>
<td>4.7 (2.03)</td>
<td>6.7 (2.85)</td>
</tr>
<tr>
<td>Fizzy drinks</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>every day</td>
<td>14 (28.0)</td>
<td>4.0 (3.88)</td>
<td>18.6 (9.77)</td>
<td>2.0 (0.95)</td>
<td>4.6 (2.21)</td>
<td>6.9 (2.95)</td>
</tr>
<tr>
<td>never</td>
<td>36 (72.0)</td>
<td>5.3 (5.63)</td>
<td>17.4 (9.04)</td>
<td>2.2 (0.76)</td>
<td>5.0 (1.65)</td>
<td>7.0 (2.21)</td>
</tr>
<tr>
<td>Total</td>
<td>50(100.0)</td>
<td>4.9 (5.19)</td>
<td>17.7 (9.04)</td>
<td>2.2 (0.81)</td>
<td>4.9 (1.81)</td>
<td>7.0 (2.41)</td>
</tr>
</tbody>
</table>

*p< 0.05
Table 6. The mean and standard deviation (SD) values of D, DMFT, M, F, T according to the use of psychoactive substances (smoking, use of alcohol, snuff and drugs) among Finnish prisoners, n= 50.

<table>
<thead>
<tr>
<th>Psychoactive substance</th>
<th>n (%)</th>
<th>D mean (SD)</th>
<th>DMFT mean (SD)</th>
<th>M mean (SD)</th>
<th>F mean (SD)</th>
<th>T mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>44 (88.0)</td>
<td>5.6 (6.07)</td>
<td>16.9 (9.17)</td>
<td>5.1 (6.19)</td>
<td>6.2 (4.81)</td>
<td>23.9 (6.56)</td>
</tr>
<tr>
<td>no</td>
<td>6 (12.0)</td>
<td>4.8 (4.54)</td>
<td>23.5 (5.72)</td>
<td>4.5 (6.72)</td>
<td>16.5 (4.32)**</td>
<td>24.5 (6.72)</td>
</tr>
<tr>
<td>Alcohol</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>36 (72.0)</td>
<td>5.5 (6.19)</td>
<td>18.4 (9.60)</td>
<td>6.4 (6.70)</td>
<td>7.0 (4.95)</td>
<td>22.6 (7.13)</td>
</tr>
<tr>
<td>no</td>
<td>14 (28.0)</td>
<td>5.6 (5.17)</td>
<td>15.8 (7.40)</td>
<td>1.4 (1.95)**</td>
<td>8.5 (7.69)</td>
<td>27.5 (2.10)*</td>
</tr>
<tr>
<td>Snuff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>10 (20.0)</td>
<td>6.6 (8.14)</td>
<td>16.4 (8.81)</td>
<td>5.3 (7.33)</td>
<td>3.0 (2.79)</td>
<td>23.6 (7.83)</td>
</tr>
<tr>
<td>no</td>
<td>40 (80.0)</td>
<td>5.3 (5.26)</td>
<td>18.0 (9.18)</td>
<td>4.9 (5.97)</td>
<td>8.6 (5.84)**</td>
<td>24.1 (6.31)</td>
</tr>
<tr>
<td>Drugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>31 (62.0)</td>
<td>6.6 (6.56)</td>
<td>18.1 (8.98)</td>
<td>5.9 (6.89)</td>
<td>5.8 (4.43)</td>
<td>22.9 (7.21)</td>
</tr>
<tr>
<td>no</td>
<td>19 (38.0)</td>
<td>3.8 (4.15)</td>
<td>17.1 (9.36)</td>
<td>3.4 (4.59)</td>
<td>10.1 (6.88)*</td>
<td>25.8 (4.83)</td>
</tr>
<tr>
<td>Total</td>
<td>50 (100.0)</td>
<td>5.5 (5.87)</td>
<td>17.7 (9.04)</td>
<td>5.0 (6.19)</td>
<td>7.4 (5.80)</td>
<td>24.0 (6.51)</td>
</tr>
</tbody>
</table>

*p<0.05, **p< 0.01

5.8 Main findings

The oral health status of Finnish prisoners was poor.

- 81% of the participants had dental caries with the need for restorative treatment.
- All participants had gingivitis; 71% of them had gingival bleeding in all sextants.
- Severe periodontal problems were found in 7% of the participants.
- Prisoners’ dental fear was associated with irregular use of dental services.
- 90% of the participants had moderate or severe erosive tooth wear.
- Temporomandibular disorders (TMD) were common among the prisoners: clinically diagnosed disorders were found in 60% of the participants and 84% reported TMD symptoms.

Factors known to decrease oral health were common: the use of psychoactive substances, dental fear, medications, poor daily dental hygiene and dietary habits, and irregular dental attendance.
6  Discussion

Measured by all indicators in this study, the oral health status of Finnish prisoners was poor in terms of dental and periodontal health. The prevalence of ETW and self-reported TMD symptoms and clinically diagnosed TMD was high. Alcohol consumers had more extracted teeth than sober ones. There was an association between restorative treatment (F) and smoking, the use of snuff and drugs: smokers, prisoners using snuff or drugs had less restorations done when comparing non-smokers, prisoners with no use of snuff or drugs. No association between ETW and the use of psychoactive substances was found, although it was hypothesized. Prisoners with dental fear did not have poorer dental health than those without dental fear. However, they attended dental care more irregularly than those with no dental fear, and as a result, they had less restorative treatment done. In addition to poor oral health-related behaviours, prisoners’ health behaviours did not favour health, either; almost all smoked, and alcohol and drug use had been common before imprisonment. Most prisoners visited dental care rarely and even then, only for acute care both in civil life and in prison. All these factors affect oral health as well and constitute a risk for both general health and oral health.

The reasons for somewhat unexpected findings may be the rather small study population and lack of favourable health and oral health habits among almost all participants. Therefore differences and associations were challenging to discover.

6.1  Study population

Almost all invited participants took part in the study, which is a strength of the present study. This study offers new scientific evidence on the oral health of prisoners in Finland, because to my knowledge, the oral health of prisoners had not been studied before. A restricted population from just one prison (n=100) can be considered a limitation of this study. However, the number of participants is in line with previous studies abroad (Heidari et al. 2007 (n=78), Decerle et al. 2012 (n=84, Cavalcanti et al. 2014 (n=127). The results obtained in this study can be considered preliminary and indicative.

The Pelso Prison is in the eastern part of Northern Ostrobothnia, in the small municipality of Vaala. The Pelso Prison houses 110 prisoners, but the number of inmates varied, in particularly the number of remand prisoners, due to transfer to another institution or release. Therefore, the actual number of prisoners during the study period is not available. The study group, however, represents well northern
and eastern Finnish prisoners, as over half (56%) of the prisoners came from the northern or eastern part of Finland (Criminal Sanctions Agency 2018).

Globally, men are more frequent in criminal populations. The number of female prisoners is increasing, and they make up 7% of the total prison population (Walmsley 2017). At the Pelso Prison, the gender distribution was the same as elsewhere, with males dominating (89% vs. 11%). In 2017 in Finland, the proportion of female prisoners was 8% (Criminal Sanctions Agency 2018).

Generally, the mean age of prisoners in literature varies between 18–35 years (Andersen 2004, Freeman & Richards 2019). Here as well, most of the participants were in their thirties, even if there was great variation. The proportion of older prisoners (aged more than 50 years) has been growing (Carson 2018) and the same trend is seen also in Finland. The proportion of older Finnish prisoners has increased from 9% to 14% in the current century (Blomster et al. 2011). In the report of Blomster et al. (2011), the percentage of older prisoners was lower than that at the Pelso Prison (9%) with a third under 30 years. The increasing age of the prisoners will bring challenges to health and oral health care in the future.

Prisoners have poor socio-economic status (SES) when measured by education, occupation and income (Friestad 2010), and low social classes are overrepresented in this group (Joukamaa 1991, Andersen 2004). Income and occupation were not included in this study. As for education, this study is in line with previous studies. In terms of education, Finnish prisoners differ from the general Finnish population (Aromaa & Koskinen 2002). Over two thirds of Finnish citizens aged 15 years or more complete either matriculation examination or vocational school after compulsory nine-year basic education (Official Statistics of Finland 2017). Among prisoners the opposite was true. Only two men had completed matriculation examination and the rest had only basic lower education level. Some prisoners had reading and writing disability, which should be kept in mind when interviewing or filling questionnaires with them or evaluating studies based on questionnaires.

6.2 Methods

6.2.1 Clinical examination

The clinical examinations were carried out by one experienced dentist. The examiner (RV) was trained and well and thoroughly calibrated before starting the study. Intra- and interexaminer calibrations for caries, ETW and TMD showed...
excellent and good agreements. Thus, having one examiner, which reduces examiner-based variation, is a strength of this study.

**ICDAS (International Caries Detection and Assessment System)**

The strength of this study is the use of the ICDAS criteria in detecting and assessing the stage of caries lesions. ICDAS is a clinical, visual scoring system for detecting and assessing different stages of caries lesions according to depth: enamel caries, non-cavitated and manifest caries lesions. Activity of lesions is often combined with ICDAS criteria. The criteria have been developed for clinical research as well as clinical practice and epidemiological purposes (Ismail *et al.* 2007). The criteria were chosen for use here in order to ensure validity and reliability of caries detection. Earlier and widely used criteria for caries evaluation and classification, the WHO caries diagnostic criteria (decayed, filled and missed) teeth due to caries), are still a commonly used, accurate and time-efficient method (Chu *et al.* 2013). However, they focus on the cavitated stages of caries, and furthermore, no assessment of caries activity exists. ICDAS active score 3 (+3) and scores 4–6 were used as cut-off point values for restorative treatment need and according to the WHO criteria, they corresponded to value D (decayed).

To get more information for diagnosing interproximal and occlusal caries, bitewing radiographs were taken when clinically indicated. The use of radiographs was in line with the recommendation of the Finnish guidelines for controlling dental caries (Current Care Guidelines). The examiner was an experienced clinician and familiar with diagnosing caries from radiographs, although not calibrated for radiography in this study, which can be considered as a limitation. All perceived information on radiographs was included in clinical findings. Dental pantomographs would have been a good addition in some cases, but the prison environment did not allow their use. On the other hand, fibre-optic transillumination (FOTI) device was used as a supplement in all clinical examinations. FOTI is routinely used by Finnish dentists.

Although the ICDAS protocol defines that teeth should be cleaned before clinical examination (Ismail *et al.* 2007), no professional tooth cleaning was included in this clinical examination because periodontal status was examined in the same session. There may be inaccuracy in the DMFT (M component) scores because only a few of the study subjects knew the causes of the tooth extractions. In addition, wisdom teeth were excluded from all analyses.
CPI (Community Periodontal Index) and BOP (Bleeding on probing)

Here as well as in most previous prison studies, CPI index was used to define and estimate periodontal disease (McGrath 2002, Heidari et al. 2007, Rouxel et al. 2013). According to Page & Eke (2007), CPI index is valuable in estimating the treatment need for periodontitis in communities, and it has been recommended for epidemiological surveys by the WHO (2013). Another clinical measurement used in this study was the BOP (bleeding on probing) index, which provides information about the presence and degree of gingival inflammation (Weinberg & Hassan 2011). Even though there are differences in age and ethnic groups and variations between study populations, the results are somewhat comparable.

ETW and BEWE

Erosive tooth wear (ETW) was first studied in Finland in the 1980s. Over the past decades, its prevalence and the interest in this phenomenon seem to have increased (Schlueter & Tveit 2014). The value of this study increased by the inclusion of ETW in the study protocol – to my knowledge, for the first time among prisoners.

Different indices for ETW have been developed, but no uniform scoring system exists. The BEWE (Basic erosive wear examination) index (Bartlett et al. 2008), which was used in this study, is simple and validated for recording erosive tooth wear (Olley et al. 2014). Here, the intra- and interexaminer agreements were excellent, supporting the reliability and reproducibility of the index used. The examiner was not previously familiar with the BEWE index but was trained on the subject by experienced senior researchers.

DC/TMD (The Diagnostic Criteria for Temporomandibular Disorders)

The TMD diagnosis has evolved significantly over the last two decades. The use of a current, reliable and valid diagnostic system (DC/TMD) (Ohrbach & Dworkin 2016) is a strength of this study. The Finnish version of DC/TMD was used here for the first time for epidemiological purposes. Because at least some of the participants had reading and writing difficulties, and to avoid misunderstanding, the Finnish version of the DC/TMD Symptom Questionnaire was used with face-to-face interview. This is also a strength of this study.
6.2.2 Information from patient records

Age and gender as well as prescribed medicines used by prisoners were obtained from their official patient records. Information about contagious diseases such as viral hepatitis and HIV infection was also acquired from their patient records. All this information can be considered reliable. However, diagnoses concerning medical conditions were not available, so the conditions were estimated according to prescribed medicines and some inaccuracies may appear in this. The researcher had no access to information on the reasons for imprisonment or the type of convictions. Unfortunately, information on prisoners’ previous dental care and dental attendance was not available.

6.2.3 Questionnaires and interviews

The questionnaires completed with assistance from the examiner and by motivational interviewing provided information on marital status, education, health and oral health behaviours. In addition, inquiries about dental and other fears as well as TMD symptoms were included. According to Portney & Watkins (2009), self-reported measures are generally valid. Initially, a few prisoners received questionnaires for self-completion, but this did not work. The questionnaires were either forgotten or not filled in. Consequently, to obtain a maximum number of responses, researcher-assisted face-to-face interview was used to fill in the questionnaires. This is a strength of the present study compared with studies where prisoners have self-completed questionnaires and where response rates have been low and datasets incomplete (Hingson & Strunin 1993). Some of these problems may be due to the low educational level and reading and writing difficulties among prisoners.

Interviewing is a meaningful way to acquire information even though it is laborious and time-consuming. Therefore, it is a less frequently used method. Interview is more reliable than questionnaire (Joukamaa M 2008) and it is a valuable method when the target group represents a group with a low level of education. By interviewing, the questions can be interpreted if needed, and answers can be specified (Hirsjärvi & Hurme 1985). The motivational interviewing (MI) technique was used here to obtain information also on intimate and difficult topics, such as substance abuse or contagious viral infections. This concept is very well suited for interviewing prisoners provided that a person’s autonomy and right to self-determination are kept in mind (Kay et al. 2016).
Dental fear and its level have been measured in numerous different ways. These include single dental-anxiety questions (Heaton et al. 2007) and multi-item scales. Using more than one measure is recommended, which was true here. The choice of measurement also depends on what is being studied and how much time is involved. Single questions and single-item scales are easier and faster to use compared with multi-item scales.

The most common dental fear multi-item scales (Corah 1969), MDAS (Humphris et al. 1995) and DVAS (Luyk et al. 1998) were used in the present study. MDAS is a reliable and valid dental fear measurement with multiple-choice questions defining the level of overall dental anxiety (Humphris et al. 2000). DVAS measures the severity of different aspects of dental fear visually (Luyk et al. 1998). DVAS is widely used and useful, even if it has not been validated. However, it was used to get a wider picture of prisoners’ dental fear.


6.3 Clinical findings

6.3.1 Dental caries and periodontal diseases

According to the results presented here, the oral health measured by clinical indices D, M, F and DMFT and CPI and BOP was poor among Finnish prisoners. For comparison, prisoners had remarkably higher numbers of decayed (D) teeth than the Finnish adults of same age group. The mean D value for prisoners was 5.0, while for Finnish citizens (35–44 years) it is 1.0 (Suominen et al. 2012). Most adult Finns, 69% of males and 85% of females, have no restorative treatment need. The corresponding figure for Finnish prisoners was distinctly lower (19%). In Finland, the proportion of prisoners with no need for restorative treatment seems to be lower than in Sweden; a recent study reported that 34% of Swedish male prisoners had no need for restorative treatment due to caries (Priwe & Carlsson 2018).

The mean DMFT value in the present study was as high as 16.8. Similar high DMFT values ranging from 10.2 to 22.5 were also observed in China, Norway, the US, the UK, France, Brazil, Australia, Italy, South Africa and Scotland (McGrath,
2002, Hurlen et al. 1984, Decerle et al. 2012, Rodrigues et al. 2014, Nobile et al. 2007, Freeman & Richards 2019). On the other hand, low DMFT values were found in Nigeria, India and Kosovo (Akaji et al. 2013, Bansal et al. 2012, Zajmi et al. 2017). The variation in results may partly be explained by cultural differences, e.g., diet, as well as differences in prison populations between countries and societies. On the other hand, there are also great differences in the prevalence of caries around the world among general populations (Kassebaum et al. 2015), not to mention in the criteria used, as well as training and calibration of the examiners.

The prevalence of adults with healthy periodontal status without periodontal pocketing has increased in many European countries and the US (König et al. 2010, Eke et al. 2015, Frencken et al. 2017). According to the results from the Health 2011 Survey (Suominen et al. 2012), periodontal health among Finns (>30 years) is not so good. Regarding periodontitis, Finnish prisoners do not differ from other Finns. Both groups have a high prevalence of periodontitis; 47% of Finns (>30 years) and 40% of Finnish prisoners (mean age 35 years) had high need for periodontal treatment as well as oral hygiene instructions. According to several international prisoner studies (McGrath 2002, Heidari et al. 2007, Nobile et al. 2007, Rouxel et al. 2013), similar results, 40% to 77%, have been reported for periodontitis (CPI ≥ 3) prevalence. Worldwide, a small proportion of adults exhibit severe periodontitis (5%–15%) (Burt & Eklund 2005). Nobile et al. (2007) reported that among male Italian prisoners, 5% had severe periodontitis (CPI 4 with pockets ≥6mm). The result of this study is similar as the corresponding proportion was 7%. In terms of future risk for periodontal disease it is alarming that two thirds of the prisoners had BOP in all sextants. Poor lifestyle with poor health and oral health-related behaviours and poor psychosocial circumstances are important aetiological factors for periodontitis among prisoners as well.

6.3.2 Erosive tooth wear (ETW)

Most of the study population required preventive, operative and restorative care due to erosive tooth wear. Furthermore, one fifth of them suffered from severe ETW. This shows the importance of detecting ETW among all patients. The figures among prisoners are higher than in other recent studies on general populations. Schlueter & Luka (2018) estimated in their recent review that globally, the prevalence of ETW in permanent teeth varies between 20% and 45%, but there is enormous variation between studies even within one country.
The prevalence of alcohol abuse and the use of illicit drugs is high among prisoners globally as well as the prisoners in this study (Baranyi et al. 2019, Fazel et al. 2017). Alcohol abuse behaviour have been found to associate with ETW (Schlueter & Tveit 2014, Teixeira et al. 2017). In the present study no clear association was found but rather tendency. The demineralising effect of alcohol on erosion can be explained by continuous exposure to alcohol with low pH (extrinsic factor). The same mechanism concerns intrinsic aetiological factors such as vomiting and long-lasting gastro-oesophageal reflux disease.

There are a few studies investigating whether ETW and illicit drug abuse are associated (Milosevic et al. 1999) and according to these results, there was more caries, hyposalivation, and attrition rather than ETW defects on dental hard tissue. However, the use of illicit drugs can deteriorate ETW as parafunctional habits including tooth grinding, clenching and bruxing are commonly associated with substance abuse (Winocur et al. 2001). It can be speculated that in the long run, hyposalivation worsens the situation. There was no association between illicit drug use and ETW among the studied Finnish prisoners.

Hyposalivation has been found to associate with ETW (Hara & Zero 2014). As a side effect, several medications reduce salivary secretion and/or change the composition of saliva. Antipsychotics and strong analgesics may reduce the activity of the salivary glands and cause hyposalivation. In addition, several different medicines (Tiisanoja et al. 2019) influence salivary secretion. Among the prisoners in this study, the use of different medications, particularly psychotropics and analgesics, was common. The high prevalence of ETW in the present study could be explained by medications, hyposalivation, and changes in saliva composition. Salivary flow was not measured, which can be considered a limitation of the study.

6.3.3 Temporomandibular disorders (TMD)

The present study revealed a high prevalence of self-reported TMD symptoms, and especially joint-related TMD clinical diagnoses among Finnish prisoners, which justifies including this topic in the study protocol. Although these prevalence findings are high, they are consistent with the general conception. DD with reduction and degenerative joint disease (DJD) are intra-articular disorders of the TMJ and they were the most prevalent TMD sub-diagnoses in the present study group. A systematic review adopting RCD/TMD by Manfredini et al. (2011) concluded that the most common TMD diagnosis among general population was DD with reduction. Similar results were also obtained in the recent Finnish study
by Jussila et al. (2017): the most common TMD diagnosis among middle-aged (45-46 years) Finns was DD with reduction. However, the prevalence (7%) was significantly lower than that among prisoners (33%).

According to a recent systematic review by Pantoja et al. (2019), the prevalence of DJD ranged from 18% to 85%. These results were obtained by combining clinical diagnoses and imaging examinations. The prevalence of DJD among Finnish prisoners was 33% and was therefore in line with Pantoja et al. (2019). This prevalence is based on clinical diagnoses only because there was no possibility for imaging examinations in the prison environment.

The factors that may associate with the development of TMD are genetic and anatomical. In addition, traumas and injuries to the face or neck can also predispose to TMD. (Rauhala et al. 2000, Okeson 2013, Häggman-Henrikson et al. 2016). Due to their way of life, accidents, injuries, and crashes are common among prisoners (Viitanen et al. 2013). When the prisoners’ general fears were asked about, the third most common fear was car accidents. At least some of the joint-related diagnoses may be explained by traumas and accidents. This was not studied here but could be a topic of future study.

In addition, somatic factors as well as psychological and psychosocial disorders are associated with pain and TMD (Sipilä et al. 2001, Kotiranta et al. 2015, De La Torre Canales et al. 2018). The most common pharmaceuticals used by prisoners were antipsychotics, analgesics and sleeping and falling asleep/insomnia medications, indicating psychological and psychosocial problems and sleep disorders. Pain-related TMD diagnoses among prisoners did not reach a high level. This could partly be explained by the use of analgesics and psychoactive substances, which can also act as analgesics. Psychoactive substances may raise the pain threshold and thus lower the feeling of pain.

6.4 Dental and other fears

Dental fear was measured with two multi-item scales, MDAS and DVAS. Consequently, in addition to prevalence, detailed information about the level and severity of dental fear was obtained. However, no generalisations should be made based on the results because the number of participants was small and all of them were males.

There are a few studies of prisoners’ dental or other fears. According to Heidari et al. (2007 and 2008), male prisoners in the UK reported high levels of dental anxiety, and this was the main reason for avoiding dental treatment. It should be
mentioned that their results were obtained using a structured interview. Compared with the Finnish prisoners, UK prisoners had higher levels of dental anxiety. However, the prevalence of dental fear among Finnish male prisoners was higher when compared with the Finnish males of same age group (Pohjola et al. 2007). Another more recent study from Scotland (Freeman & Richards 2019) reported that the mean score for dental anxiety in terms of MDAS was moderate, which was also true in the present study.

The aetiology of dental fear is mostly related to exogenous factors (Weiner and Sheehan 1990), and especially to negative experiences (Öst, 1987). Dental fear can sometimes originate from endogenous factors (Weiner & Sheehan 1990) and may be a sign of a more generalized anxiety syndrome with psychological disorders, such as anxiety disorders, behavioural problems, mood disorders, alcohol and substance abuse problems, and social phobia (Locker et al. 2001, Pohjola et al. 2011). All these are prevalent among prisoners (Fazel et al. 2016), as they were here, too. Use of tobacco products can be one indicator of prisoners’ dental fear, since smoking has also been found to be associated with dental fear (Pohjola et al. 2013). On the other hand, in prisoners the impact of smoking on dental fear is difficult to assess since almost all are smokers (Heidari et al. 2007 and 2008), as was also the case here.

The prisoners of this study were most afraid of painful dental procedures as well as pain in general. Heidari et al. (2007) had similar results, intra-oral injections and use of drill being the most fear-arousing dental procedures. In this respect, prisoners do not differ from the general population (Berggren 1992, Taskinen et al. 2014).

A relationship has been shown to exist between general fearfulness and dental anxiety (Berggren 1992). Furthermore, more than 90% of adults with dental anxiety reported having at least one additional extreme fear (Berggren 1992). The present study indicated an association between dental and general fears, since one third of the prisoners had at least one extreme fear. Fear of heights, flying, enclosure, and mutilation has been associated with dental fear (Armfield 2008). Among the prisoners here, the profile of general fears was somewhat different: fear of heights was the most frequently reported fear, followed by fear of public situations, car accidents, injections, and snakes.

Dental fear often results in avoidance behaviour and using dental care only in acute situations (Pohjola et al. 2007). The results were the same in the present study. The prevention and treatment of dental fear involves taking into consideration the
patient with or without dental fear, good anamnesis, good pain relief and good rapport with the patient.

6.5 General health

Prisoners’ health problems are somewhat different from those of the general population. Prisoners are mostly adult males, in their 20s and 30s, and they come from lower socio-economic groups. In addition, they have risky health behaviours \textit{per se}. In the present study, the use of prescribed medicines as well as substance abuse, mental health problems and history of traumas and injuries were common. Some medicines, e.g. analgesics and benzodiazepines can be associated with the misuse of medicines (Lintonen et al. 2011).

Diagnoses of prisoners’ diseases were not available for the research group. However, certain prescribed medications used by prisoners indicated diseases that affect oral health as well. The medicines used by the present study population include antipsychotics, analgesics and medication for insomnia, which can indeed affect oral health (Fratto & Manzon 2014, Ciancio 2004, Tiisanoja et al. 2019).

6.6 Health- and oral health-related behaviours

6.6.1 Substance abuse

Substance use was common among the Pelso prisoners. Most of the prisoners were smokers; in this respect, the study population was different from the general population. This is a cause for concern as smoking clearly decreased among Finnish men in all age groups during the years 2000–2011 (Suominen et al. 2017). Smoking has been proven to have harmful effects on oral health and is an independent risk factor especially to periodontal health (Genco et al. 2013). Smoking is a major risk factor for oral cancers (Johnson 2001, Gandini et al. 2008). According to Tanner et al. (2015), there may be other harmful health behaviours associated with smoking, such as alcohol consumption and drug abuse. Those with low socioeconomic status (SES) smoke more often compared with those with higher SES status (Hiscock et al. 2012).

Abusive alcohol use was common among the present study sample; nearly half reported drinking alcohol at least once a week in civil life. This is in accordance with general Finnish male population (the Health Survey 2011). Alcohol abuse is
commonly associated with dental caries, periodontal diseases, erosive tooth wear and xerostomia or hyposalivation, as well as traumatised teeth and oral cancer (Arujo et al. 2004, Teixeira et al. 2018).

Use of psychoactive substances, e.g. illicit drugs and misuse of medicines as well as combined use of various intoxicating substances and drugs was prevalent among Finnish prisoners. Similar results have been obtained in many other prison studies (Lintonen et al. 2011, Priwe & Carlsson 2018). Drug use among Finnish prisoners is tenfold compared with the general Finnish population (Joukamaa et al. 2010). Drugs affect oral health in many ways. Severe caries, periodontal diseases, hyposalivation and xerostomia, bruxism, erosive tooth wear, oral mucosal lesions, and even cancer can be the result of drug use (Rees 1992, Baghaie et al. 2017, Fazel et al. 2017).

6.6.2 Oral health-related behaviours

Prisoners’ chaotic lifestyle outside prison does not favour good oral health or oral health-related habits. On the contrary, it contributes to poor oral health with poor oral health habits and low use of dental care. Surprisingly, seven prisoners reported never having visited a dentist. Similar figures were reported by Heidari et al. (2008): one fifth of the participants had never visited a dentist. Prisoners mostly use dental services irregularly and solely for acute dental care (Heidari et al. 2008); in the present study of Finnish prisoners as well. Dependency on psychoactive substances, especially illicit drugs, is a potential factor for non-regular dental attendance, poor oral health as well as dental anxiety (Acquah et al. 2005). Acquah et al. did not investigate prisoners, but the results apply to prisoners as most prisoners are drug users. According to Heidari et al. (2008), the primary reason for prisoners not to visit a dentist was dental anxiety; this was in many cases true of Finnish prisoners, too.

A combination of sugar and other unhealthy dietary habits and snacking have an association with dental caries (Catteau et al. 2013), which association was not found in the present study, most probably due to the prevailing unhealthy lifestyle of prisoners: the use of different psychoactive substances, poor hygiene and poor oral hygiene habits and poor dietary habits.

A few previous studies have investigated prisoners’ daily oral hygiene habits (Nobile et al. 2007, Heidari et al. 2007 and 2008). The results are similar as in the present study: prisoners reported brushing their teeth regularly, even twice a day, but their gingival condition was poor all the same. The reasons for this can only be
speculated. Prisoners’ knowledge of good daily dental hygiene and practices may be limited, or possibly they just do not care.

The common use of psychoactive substances (smoking, alcohol consumption, drugs) and poor oral hygiene habits were associated factors for periodontal diseases in the present study as indicated by high BOP and CPI indices. Nearly half of the prisoners brushed their teeth twice a day, which is a little less compared with Finnish men aged 30–44 years (Suominen et al. 2012).

### 6.7 Clinical implications and future studies

There is scarce information about the oral health status of Finnish prisoners. The present study was the first oral health survey to provide baseline information on the topic. Further studies on different prisons and on larger study populations would be valuable. Moreover, separate studies on the oral health of female prisoners are needed. Viitanen et al. (2013) reported that the general health of Finnish female prisoners was worse than that of males. Are there similar gender differences in oral health as well? The present study population did not allow this analysis. In addition, foreign and older prisoners are growing groups, and no information exists on their oral health. In the future, regular evaluations of prisoners’ oral health and oral health-related behaviours are needed to monitor changes in the oral health status of this marginal group of people. Is the improvement of dental care in the general population also seen in prisoners’ oral health status? It would also be important to study how prisoners value their oral health.

The present study is cross-sectional. Mixson et al. (1990) and Heidari et al. (2014) found that prisoners who had been in prison for more than two years had better oral health than prisoners with shorter sentences. However, more longitudinal studies are needed to determine whether imprisonment has an impact on prisoners’ health and oral health as well. In prison, the life of prisoners is at least partly regular and routine, with regular mealtimes and activities, which could be used to improve prisoners’ oral health behaviours and self-care.

In Finland and elsewhere in the world, the use of illicit drugs and other psychoactive substances has increased and is still rising (EMCCDA 2019). However, their use among prisoners is multiple (Lintonen et al. 2011, Fazel et al. 2017). Prison studies provide information on factors affecting oral health associated with different drugs and substances. However, assessing the effects of individual substances is challenging because prisoners may use many psychoactive substances together.
Prisoners have the same entitlement to dental care as other patients (Finnish Non-Discrimination Act, 1325/2014). Even though many prisoners require special dental care, their dental care can be provided in general dental practice. Dentists have an important role to play in detecting and preventing psychoactive substance use as well as in promoting oral health through diet and hygiene education. Dentists are required to work together the multidisciplinary health care team within the prison system to improve the overall oral health and general health of prisoners. Better oral health can improve the prisoner’s psychosocial life, physical activity and functioning as well as their self-esteem. Compassionate and considerate dental care can prevent dental fear.

Good oral health is linked to overall health and vice versa. The information obtained from the present study can be utilised in oral health promotion and education which are needed at every stage of imprisonment. For many individuals, imprisonment may be the only regular and peaceful time in the otherwise chaotic lifestyle of the prisoner.
7 Summary and conclusions

According to the present study results, the oral health of Finnish prisoners is poor, and mostly poorer than among Finnish adult population. The risky health habits, common use of psychoactive substances, poor hygiene and unhealthy dietary habits and generally chaotic lifestyle do not support good oral health. On the contrary, they can promote oral health problems and minor use of dental services. Because of this, poor oral health is not due to imprisonment but rather to the way in which prisoners live before being sentenced to prison. The findings of this study are in line with the results of previous studies carried out outside Finland.

Erosive tooth wear was common among Finnish prisoners. Association between ETW and restorative treatment done (F) existed but not between ETW and psychoactive substances. The background factors for ETW may be prisoners’ lifestyle with unhealthy dietary habits, acid drinks and abusive and excessive use of alcohol. These factors can be explanatory for dental caries as well.

The prevalence of TMD, both self-reported and clinically diagnosed, was high among the study group. Joint-related diagnoses were much more frequent than pain-related diagnoses. This could partly be explained by the prisoners’ way of life. Various traumas, accidents, fights and crashes are prevalent. The common use of drugs, especially antipsychotics and analgesics, can decrease pain and thus distort results. The examination and treatment of TMD are important in prison dental care, as is informing prisoners about the background factors of TMD.

The prevalence of dental fear among Finnish male prisoners was higher in comparison with Finnish general male population of same age. Studies on prisoners’ dental fear are scarce, but the findings of the present study indicate that many prisoners are dentally anxious. When treating these patients, it is important to take dental fear into consideration.

To conclude, most prisoners need a variety of dental care, whether it be preventive, restorative and/or periodontal treatment or treatment for TMD or ETW. Prisoners have poor health and oral health behaviours and they need information, guidance and support to improve self-care for better oral health. It must be borne in mind that they are often afraid of dental care, which hinders them from visiting a dentist regularly. They also need information on how oral health affects overall health and the consequences of poor oral health in their daily life. A dental check-up for prisoners entering the prison is thus a must.
References


Current Care Guidelines: http://www.kaypahoito.fi/hoi50078


Appendix

Oral health and oral health-related questionnaire for respondents, translated from Finnish.

1. Do you live?
   In a city?
   In the countryside?
   No permanent address (poste restante)?

2. Your education:
   No education
   Compulsory basic education of 9 years
   Vocational school
   Matriculation exam or gymnasium
   College
   University of applied sciences
   University
   Other

3. Marital status
   Single
   Married / cohabiting
   Divorced
   Widow

4. Do you have a chronic illness requiring regular medication?
   Yes
   No

5. How often do you eat the following snacks?
   Never or hardly ever / Every day or almost every day / Occasionally during the week
   Candy / Sweets
   Chips
   Fizzy drinks / Soft drinks
Energy drinks
Sport drinks
Juice
Biscuits
Bakery
Chocolate
Raisins
Tee
Coffee / Coffee + sugar and / or milk

6. **How many euros do you spend weekly on snacks (products like fizzy drinks and candy)?**
   - euros
   - 0
   - 1-5
   - 6-9
   - 10-15
   - 16-19
   - ≥20

7. **What do you usually drink with meals?**
   - Milk
   - Juice
   - Concentrated juice
   - Tap water
   - Fizzy drinks with sugar
   - Light/Diet fizzy drinks
   - Light/Diet concentrated juice
   - Energy drinks
   - Bottled water
   - Other

8. **What do you usually drink to quench thirst?**
   - Milk
   - Juice
   - Concentrated juice
   - Tap water
Fizzy drinks with sugar
Light/Diet fizzy drinks
Light/Diet concentrated juice
Bottled water
Other

9. Do you smoke?
   No
   1-20 cigarettes daily
   >20 cigarettes daily

   At what age did you start smoking?

10. In civil life did you consume alcohol.
    No
    Twice a month or less frequently
    Once a month
    Every other week
    About once a week
    More than once a week

    At what age did you start drinking?

11. In civil life did you use snuff.
    Yes
    No

    At what age did you start using snuff?

12. In civil life did you use drugs.
    Yes
    No

    At what age did you start using drugs?

13. How often do you brush your teeth?
Never or hardly ever
Every day or almost every day
Now and then during the week

14. How many times do you brush your teeth (when you brush every day)?
   Once a day
   Every day or almost every day
   Now and then during the week

15. Do you use dental floss or interdental brush or toothpicks?
   Never or hardly ever
   Every day or nearly every day
   Now and then during the week

16. Do you have dental symptoms / tooth ache?
   Yes
   No

17. Does drinking or eating sour items or temperature changes cause pain in your teeth?
   Yes
   No

18. Do you think you have need for dental treatment?
   Yes
   No

19. Have you had
    Yes / No
    Your teeth restored?
    Your teeth scaled, polished?
    Individual dietary instructions?
    Individual oral hygiene instructions?
    Orthodontic treatment?
    Teeth extracted?
Used nitrogen oxygen because of dental fear
Used oral conscious sedation because of dental fear

20. How often do you visit a dentist?
   - Only when I have pain or other problems
   - Regularly for check-ups
   - Never
Original publications


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1536. Terho, Henri (2019) Electrocardiographic risk markers for cardiac events in middle-aged population


1538. Ylönen, Susanna (2019) Genetic risk factors for movement disorders in Finland


1541. Tiri, Hannu (2019) Comorbidities and mortality of hidradenitis suppurativa in Finland

1542. Hynninen, Johanna (2019) Status epilepticus in mitochondrial diseases and the role of POLG1 variants in the valproic-acid induced hepatotoxicity

1543. Urpilainen, Elina (2019) The role of metformin and statins in ovarian and breast cancer in women with type 2 diabetes


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