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Prevalence of oral diseases among adolescents in prisons in Taiwan: a populationbased study

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Abstract

Objective The aim of this study was to estimate the prevalence of oral disease in Taiwanese adolescent prisoners.

Methods We included 1,610 participants from the National Health Insurance (NHI) Program. Outcomes were measured using the clinical version of the International Classification of Diseases, Ninth Revision (ICD-9-CM).

Results The prevalence rate of oral diseases among adolescent prisoners in Taiwan was 29.38%, which was slightly higher among male (30.02%) adolescent prisoners than among female (27.34%) adolescent prisoners (p=0.316). Among all the patients diagnosed with oral diseases, the top three disease categories were hard tissues of teeth diseases (19.01%), gingival and periodontal diseases (7.70%), and diseases of the oral soft tissues, excluding lesions specific for the gingiva and tongue (4.16%).

Conclusion Oral disease is not rare among Taiwanese adolescent prisoners. Early prevention and appropriate treatments are important. It is also essential to explore sex-specific needs for this subpopulation.

Keywords Taiwanese adolescent prisoners, Prison, Oral disease, Sex difference

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Introduction

The World Health Organization (WHO) Global Oral Health Status Report (2022) estimates that oral diseases affect nearly 300 million people worldwide, three-quarters of whom live in middle-income countries [1]. Globally, an estimated 500 million people suffer from dental caries in their permanent teeth, and 340 million children suffer from dental caries in their primary teeth [2]. Most oral health conditions are largely preventable and treatable at an early stage [3]. Most cases are dental caries (tooth decay), periodontal disease, tooth loss and oral cancer [4]. Oral disease, although largely preventable, constitutes a significant health burden in many countries and affects people throughout life, causing pain, discomfort, disfigurement and even death [5]. Oral disease disproportionately affects poor and socially disadvantaged groups [6].

There is a strong and consistent link between socioeconomic status (income, occupation, and education level) and the prevalence and severity of oral diseases [7]. This association is evident from early childhood to old age and is observed across populations in high-, middle-, and low-income countries [8].

According to statistics, approximately 25% of children in Taiwan do not brush their teeth twice a day [9]. A recent survey on the oral health of Taiwan's young generation also revealed that as many as 65% of young people had tooth pain in the past 2 years, gingival inflammation and bleeding, or tooth sensitivity and other symptoms; moreover, 30% of people did not have the habit of regular oral examinations and continued to ignore their symptoms [9, 10]. In the long run, these health inequalities are associated with potential additional societal burdens and medical expenditures; not only will the severity of oral diseases increase, but more money and time will be spent on treatment [11].

Despite being incarcerated, adolescent prisoners retain the fundamental right to access national health insurance and maintain their health [12]. However, significant challenges exist in providing healthcare services within the prison environment compared with the general population [13]. These challenges include limited autonomy, poor access to healthcare and social exclusion [14]. Typically, they can only receive treatment within the prison's medical facilities or at designated external hospitals, which may hinder their access to comprehensive medical services. Medical resources in prisons are often relatively limited, making it difficult to provide the same level of medical technology and equipment as comprehensive hospitals do [15]. Additionally, previous findings revealed that prisoners might be less likely to trust the healthcare system, implying an impediment to receiving adequate care while being incarcerated [16].

Prisoners have a greater risk of developing oral diseases [17]. Importantly, this implies that resource constraints and specific challenges in prison settings may affect the delivery of oral health services [18]. Academic evidence suggests that the prevalence of oral diseases among adolescent prisoners in prisons varies depending on region, prison management policies, and demographic data [19]. Owing to the lack of comprehensive data describing the prevalence of oral diseases, the true frequency and burden of these conditions may be underestimated. Given the need to provide equitable healthcare for adolescent prisoners, addressing their health is in the public interest. Therefore, the aim of this study was to analyze data from the Taiwan National Health Insurance Research Database (NHIRD) to present an overview of oral disease among adolescent prisoners in Taiwan, improve healthcare professionals' recognition of the most common oral diseases, and provide evidence for health policy decision-making.

Materials and methods

Data source

Taiwan's NHI system covers 99% of the population. The NHIRD was developed on the basis of anonymized linked data from the NHI for epidemiologic and clinical research [20]. From 1995 to 2016, the NHIRD used the International Classification of Diseases, Ninth Revision Clinical Modification (ICD-9-CM). The ICD-10 has been used since 2017 [21]. Details of this data source and design are described elsewhere [22].

Study design and study population

This study specifically focused on all adolescent prisoners aged ≥ 10 and < 20 years [23]. Figure 1 shows the study sample selection process. We extracted claims data for all prisoners from January 1 to December 31, 2013, including 1,122,922 individual outpatient data points and 15,383 individual hospitalization data points. Finally, this study included 1,610 prisoners. We combined the medical records of both outpatient and inpatient visits and summarized the data for each individual.

In Taiwan, every prison has well-trained dentists employed by affiliated hospitals. The prisoners typically meet with dentists for "medical advice" for no more than 1 week. They receive immediate assistance for emergency oral disease. The dentists diagnose the oral disease when the prisoners apply for medical advice, and the NHIRD stores all the related ICD-9 codes. The ICD-9 codes ranging from 520 to 529 serve as the primary classification for oral disorders, encompassing diseases related to the oral cavity, salivary glands, and jaws. These oral diseases are categorized as follows: disorders of tooth development and eruption (ICD-9 codes 520); diseases of hard tissues of teeth (ICD-9 codes 521); diseases of pulp and periapical tissues (ICD-9 codes 522); gingival and periodontal



Fig. 1 The flowchart of this study sample selection. CD: datasets of ambulatory care expenditures by visits; DD: datasets of inpatient expenditures by admissions; NHIRD: National Health Insurance Research Database

diseases (ICD-9 codes 523); dentofacial anomalies, including malocclusion (ICD-9 codes 524); other diseases and conditions of the teeth and supporting structures (ICD-9 codes 525); diseases of the jaws (ICD-9 codes 526); diseases of the salivary glands (ICD-9 codes 527); diseases of the oral soft tissues, excluding lesions specific for the gingiva and tongue (ICD-9 codes 528); and diseases and other conditions of the tongue (ICD-9 codes 529). To ensure data quality, prisoners had to be diagnosed at least three times in one category, with the result interpreted as oral diseases [22].

Ethical considerations

This study was conducted with data from the NHIRD and NHI. To ensure privacy protection, the names of patients, healthcare providers, and institutions were encrypted, and all identified numbers of insured individuals were replaced with unique substitute numbers. The study was approved by the Institutional Review Board Research Ethics Committee of Taizhou Hospital of Zhejiang Province (TZH-IRB: K20240836). All procedures met the required guidelines, and all participants did not need to provide informed consent because of the use of an anonymized database.

Statistical analysis

SAS for Windows (version 9.4; SAS Institute Inc., Cary, NC, USA) was used to perform all analyses in this study. We provided the mean and standard deviation (SD) for age. For prevalence, we provided absolute values and percentages. We also performed a χ 2 test to assess differences in the percentages of diseases in the oral cavity, salivary glands, and jaws by sex.

Results

This study included data from 1,610 prisoners (Fig. 1), comprising men (76.14%) and 23.85% women. The mean ages of the female and male prisoners were 13.98 (SD: 6.57) and 17.41 (SD: 3.03), respectively. The mean ages for females and males whose oral cavity, salivary glands, and jaws were affected were 17.10 (SD: 2.90) and 17.71 (SD: 2.30), respectively (Table 1).

The prevalence of oral cavity, salivary gland, and jaw disease among females was 27.34%, whereas the

Variables	Total		Diseases of oral cavity, salivary glands, and jaws			
	Female (<i>n</i> = 384)	Male (n = 1226)	Female (<i>n</i> = 105)	Male (<i>n</i> = 368)		
Age						
Mean (standard deviation)	13.98 (6.57)	17.41 (3.03)	17.10 (2.90)	17.71 (2.30)		
Range (min-max)	2-19	2-19	2-19	3-19		
Medicine Service Times (a year)						
Mean (standard deviation)	10.93 (9.33)	12.51 (9.65)	16.35 (9.10)	17.51 (10.97)		
Range (min-max)	1–52	1-72	5–47	2–70		

Table 1 Demographics of the participating sample by gender (n = 1,610, Taiwan, 2013)

Table 2 Prevalence of oral cavity, salivary glands, and jaws diseases by gender by a survey of year 2013 claims data from the Taiwan National health insurance program (*n* = 1,610, Taiwan, 2013)

Variables		Female			Male		
	n	%	mean age (S.D.)	n	%	mean age (S.D.)	
Total prisoners		23.85	13.98 (6.57)	1226	76.15	17.41 (3.03)	
ICD9_520–529 Diseases of oral cavity, salivary glands, and jaws		27.34	17.10 (2.90)	368	30.02	17.71 (2.30)	
ICD9_520- Disorders of tooth development and eruption		0.26		0			
ICD9_521- Diseases of hard tissues of teeth	67	17.45	16.72 (3.45)	239	19.50	17.67 (2.24)	
ICD9_522- Diseases of pulp and periapical tissues	8	2.08	17.25 (1.28)	22	1.79	16.86 (2.98)	
ICD9_523- Gingival and periodontal diseases		9.90	17.84 (1.05)	86	7.01	18.30 (1.05)	
ICD9_524- Dentofacial anomalies including malocclusion		0.52	18.00 (1.41)	2	0.16	19.00 (0.00)	
ICD9_525- Other diseases and conditions of the teeth and supporting structures		0.52	13.50 (4.95)	3	0.24	14.33 (5.03)	
ICD9_526- Diseases of the jaws				0			
ICD9_527- Diseases of the salivary glands				2	0.16	18.5 (0.71)	
ICD9_528- Diseases of the oral soft tissues excluding lesions specific for gingiva and		2.86	17.82 (1.17)	56	4.57	17.21 (3.22)	
tongue							
ICD9_529- Diseases and other conditions of the tongue	0			1	0.08		

prevalence in males was slightly greater (30.02%) (p = 0.316). Among female adolescent prisoners, the top three oral cavity, salivary gland, and jaw diseases were hard tissues of teeth (17.45%), gingival and periodontal diseases (9.90%), and diseases of the oral soft tissues, excluding lesions specific for the gingiva and tongue (2.86%). Among male adolescent prisoners, the top three oral cavity, salivary gland, and jaw diseases were hard tissues of teeth (19.49%), gingival and periodontal diseases (7.01%), and diseases of the oral soft tissues, excluding lesions specific for the gingiva and tongue (4.57%) (Table 2).

A total of 29.38% of adolescent prisoners had oral cavity, salivary gland, or jaw disease. The prevalence of the most common oral cavity, salivary gland, and jaw diseases by sex is shown in Fig. 2. The diseases with the highest prevalence were hard tissues of teeth diseases (19.01%), gingival and periodontal diseases (7.70%), and diseases of the oral soft tissues, excluding lesions specific for the gingiva and tongue (4.16%). There was no significant difference in the prevalence of oral cavity, salivary gland, or jaw disease between adolescent females and males.

Discussion

Clinical implications

The aim of this study was to investigate the profile of oral, salivary gland and jaw diseases among adolescent prisoners. To our knowledge, this is the first study to describe oral disease among adolescent prisoners in Taiwan. The main finding was that the prevalence of oral diseases among adolescent prisoners was 29.38%, and male adolescent prisoners had a slightly higher prevalence of oral, salivary gland and jaw diseases than females did.

The quality of life of prisoners is significantly impacted by oral diseases, which can also affect their ability to eat and speak and can cause pain and discomfort [24]. Improving oral health can improve overall health [25]. For example, periodontal disease has been linked to cardiovascular disease, high blood pressure, stroke, diabetes, dementia, respiratory disease and mortality, with inflammatory pathways proposed as the underlying mechanisms [26]. Efforts to improve public health and reduce health inequalities should include prisons, an effort by countries to leave no one behind, achieve universal health coverage and achieve the United Nations Sustainable Development Goals [27]. The WHO recommends reducing any "avoidable or unfair" health disparities, stating



Fig. 2 (See legend on next page.)

(See figure on previous page.)

Fig. 2 The prevalence of oral cavity, salivary glands, and jaws diseases among prisoners by gender, (A) ICD9_520- Disorders of tooth development and eruption, (B) ICD9_521- Diseases of hard tissues of teeth, (C) ICD9_522- Diseases of pulp and periapical tissues, (D) ICD9_523- Gingival and periodontal diseases, (E) ICD9_524-Dentofacial anomalies including malocclusion, (F) ICD9_525- Other diseases and conditions of the teeth and supporting structures, (G) ICD9_526- Diseases of the jaws, (H) ICD9_527- Diseases of the salivary glands, (I) ICD9_528- Diseases of the oral soft tissues excluding lesions specific for gingiva and tongue, (J) ICD9_529- Diseases and other conditions of the tongue

that prisoners have the right to equal access to medical care [28].

The main finding was that the prevalence of oral diseases was greater in adolescent prisoners than in adult general prisoners [17], indicating that prison staff should pay attention to the exact number of prisoners suffering from oral, salivary gland, and jaw disorders. Incarcerated people are at high risk for lacking knowledge and the ability to utilize dental care [29, 30]. A previous study revealed that more than half of juvenile prisoners had poor (53.3%) oral hygiene, a high prevalence of dental caries and fair-to-bad oral hygiene, indicating poor oral health status [31]. People living in correctional facilities had higher rates of untreated decay, poorer periodontal health, and a higher incidence of urgent dental needs than did the noninstitutionalized population; moreover, there was a higher rate of decayed, missing, or filled teeth in this population [32-33].

The prevalence of oral, salivary gland, and jaw diseases was only slightly higher in male adolescent prisoners than in female prisoners in Taiwan.

Previous studies have shown that females have significantly better oral health knowledge, a more positive attitude toward oral health, a healthier lifestyle, and better oral health behaviors than males do [34, 35]. The positive oral health behaviors and attitudes of females may be explained by the generally greater concern about appearance in females [36]. Individual health literacy influences decisions about health and behavior [37]. Greater oral health literacy is associated with more frequent tooth brushing and better oral hygiene, which may partly explain why females brush and floss more often than males do [38].

Clinical practice

Health care systems are challenged in providing prisoners with the right health services at the right time, but they also have an opportunity to provide equitable health care. The results of this study can serve as baseline data on the impact of incarceration on the oral health of adolescent prisoners and as a guide for the comprehensive planning of oral health services for adolescent prisoners in prison settings [39]. Practical interventions such as oral health education programs, mobile dental clinics, or prison-specific dental products should be proposed to address the high prevalence of oral diseases. Slight sex differences make it crucial to produce and prepare adolescent male-specific oral care products [40, 41]. Given that oral diseases and conditions are largely preventable, a stronger focus on systemic reforms, emphasis on oral health promotion and oral disease prevention is key to optimizing prisoners' oral health, including integrating oral health into prison healthcare policies [42, 43].

Methodological considerations

A notable strength of this study is the substantial sample size, as we included all adolescent prisoners in Taiwan, which enabled us to obtain a comprehensive profile of oral, salivary gland, and jaw diseases among this population. Consequently, the potential for sample selection bias has been minimized. In addition, our results were measured using standardized ICD codes, enhancing the comparability of the findings.

However, this study has several limitations. First, this was a descriptive cross-sectional study, which, while useful for estimating prevalence, does not allow for the inference of causality or the exploration of risk factors. Future longitudinal studies with extended follow-up periods are necessary to identify potential exposures related to oral, salivary gland, and jaw diseases. Second, the findings of this study are specific to adolescent prisoners in Taiwan and, owing to differences in healthcare systems and cultural contexts, may not be generalizable to other settings. Third, the manuscript also lacks an analysis of confounding factors such as dietary habits, smoking, mental health conditions, and oral hygiene practices, which could provide a more nuanced understanding of the determinants of oral health disparities. Fourth, bias estimates may have occurred due to disparities in clinical diagnoses among different dentists. Fifth, the one-year follow-up period is insufficient for observing long-term trends, and the overreliance on ICD-9 codes may underestimate the true prevalence of oral diseases by excluding undiagnosed cases. Sixth, the ICD-9 code range includes diseases of the oral cavity, salivary glands, and jaw for 520-529, which is a medical classification list by the WHO. However, classification into three categories on the basis of the ICD-9 codes (520-529) is very difficult. Seventh, studies on adolescents generally focus on basic oral health issues, such as dental caries, and the impact of oral health on quality of life. There is limited research involving the use of ICD-9 codes for diagnosing oral diseases, making it challenging to compare the oral health conditions of incarcerated individuals with those of healthy adolescents. Finally, the one-year follow-up period is insufficient to observe long-term trends

in oral, salivary gland, and jaw disease among adolescent prisoners in Taiwan. Future studies should adopt mixed methods, incorporate confounding variables, and extend the study to other regions or countries to increase generalizability.

Conclusions

Oral disease is not rare among Taiwanese adolescent prisoners. Early prevention and appropriate treatments are important. It is also essential to explore sex-specific needs for this subpopulation.

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Author contributions

Yu-Pei Yang: Conceptualization, methodology, formal analysis, writingoriginal draft, data synthesis. Ho-Tsung Hsin: Methodology, writing- original draft. Zhu Liduzi Jiesisibieke: Formal analysis; methodology. Yen-Chun Wang: Formal analysis; methodology. Bing-Long Wang: Conceptualization, methodology. Pi-Ching Yu: Conceptualization, methodology. Shi-Hao Huang: Conceptualization, methodology. Ren-Jei Chung: Conceptualization, methodology. Yao-Ching Huang: Conceptualization, methodology, supervision. Tao-Hsin Tung: Conceptualization, methodology, supervision, formal analysis, writing- review & dediting.

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Data availability

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Cheng-Hsin General Hospital (CHGH-IRB: (471) 104–07). All the participants provided informed consent. All methods were performed in accordance with the relevant guidelines and regulations stipulated in the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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