

An investigation of the risk factors and effects of methamphetamine on oral health

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DEDICATION

To my wife, Mare for her constant love, patience and support in making it all possible



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- A way out
- Akron
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- Sultan Bauw Bonteheuwel
- Sultan Bauw Mitchels Plain
- Tafelsig Matrix
- Teen challenge
- Tehilla
- Tharagay
- Toevlug



The Provincial Department of Social Development of the Western Cape

The City of Cape Town

DECLARATION

I, the undersigned, hereby declare that the work contained in this dissertation is my original work and that it has not been previously in its entirety or in part submitted at any university for a degree.



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Dr Dirk Albertus Smit

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Date

LIST OF ABBREVIATIONS

ADHD: Attention Deficiency Hyperactivity Disorder

CEJ: Cemento-Enamel Junction

DMFT: Decayed Missing and Filled Teeth

HIV: Human Immunodeficiency Virus

SACENDU: South African Community Epidemiology Network on Drug Use

UNODC: United Nations Office on Drugs and Crime

WHO: World Health Organization

XLA: Dental extraction

KEY WORDS



Bruxism

Dental caries

Fluoride

Hyposalivation

Methamphetamine

Saliva

Trismus

Xerostomia

ABSTRACT

Aim: The aim of the study was to document the oral health status of individuals using methamphetamine.

Introduction: Methamphetamine (TIK) is a highly addictive drug that acts as a stimulant for the central nervous system. The clinical picture of methamphetamine abuse is termed “Meth Mouth” and can be explained by contributing factors such as dry mouth, a poor appetite, consumption of large amounts of soft drinks and poor oral hygiene.

Materials and Methods: A cross-sectional study was conducted at 22 different substance addiction treatment centres in the Western Cape. A questionnaire was administered to elicit demographic details, diet, drug addiction, dental status and medical history. The aim of the study was to document the oral health status of methamphetamine users. The study consisted of a convenience sample of 308 participants who used methamphetamine as a primary drug of choice. An oral examination was performed to measure dental caries status (DMFT) and treatment needs.

Results: The majority was male, unemployed and between 25 and 29 years old. The mean duration of drug addiction was 6 years predominantly on a daily basis and 93.51% by smoking the drug. The mean DMFT was 10 and dental extractions were the most common procedure performed at the last dental visit. A significant difference was observed between levels of education and the mean number of extractions that were required per participant. The duration of exposure to methamphetamine was related to the number of decayed, missing and filled teeth. The majority experienced a bad taste, stiff facial muscles and a dry mouth when using the drug. Diet included large quantities of liquids (mainly beer and soft drinks) and the majority reported having a poor appetite. Users brushed their teeth less frequently when using methamphetamine.

Conclusion: Data on harmful effect of methamphetamine on dental health is consistent with published reports. Attention should be given to dental caries prevention to support users during recovery and to educate those who might be at risk.

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CHAPTER 1: INTRODUCTION

Methamphetamine is a highly addictive, man-made drug that acts as a stimulant for the central nervous system. It is also known as ‘TIK’ because of the noise made when the drug is heated in a glass tube. The drug is ingested in various ways. It can be swallowed, smoked, ingested nasally or snorted and injected (Goodchild & Donaldson, 2007; Shaner, 2002). Methamphetamine use is characterized by a cyclical pattern of abuse that is self-sustaining. It is a white powder (odorless and crystalline) and dissolves readily in water or alcohol (Figure 1). The drug is readily available, easily produced, affordable and highly profitable (Shaner, 2002).



Figure 1: Crystalline form of methamphetamine

Media reports and scientific literature indicate that there has been a huge increase in the prevalence of methamphetamine users globally (UNODC, 2013). Drug-related violence affects the operational activities of police officers, teachers and health care workers and leads to rising crime rates. Additionally, there is an increased burden on psychiatric institutions due to the neurological and psychological adverse effects of methamphetamine abuse.

Methamphetamine is a potent central nervous stimulant and is rapidly addictive. It is also known by other names such as speed, crystal meth, ice, chalk, poor man's cocaine, fire and crank (Goodchild & Donaldson, 2007).

Ingredients such as ephedrine, pseudoephedrine, lithium, hydrochloric acid, iodine, ether, lye, chloroform, Freon, Drano, drain cleaner, battery acid, red phosphorus, lighter fluid, lantern fuel, rock salt, dry ice and propane are used to manufacture illegal methamphetamine (Goodchild & Donaldson, 2007; Shaner, 2002). During World War II the pharmacological properties of methamphetamine became known and many soldiers were given the drug to enhance their performance (Lee *et al.*, 1992).

The drug leads to permanent changes in neurological processes, an increase in violent behaviour, higher susceptibility to HIV (Morris & Parry, 2006) and consequent decreased oral health. The detrimental effect on the teeth maybe related to the xerostomia, high acidity of the methamphetamine as well as personal hygiene neglect due to the psychotic adverse effects. Methamphetamine abuse also causes severe adverse effects on hard and soft intra oral structures and pathological changes. It is essential to investigate the diet preference, drug history and dental status of people that are using methamphetamine because these risk factors may contribute to poor oral health (Shaner, 2002).

During recent years the number of users of this substance has reached alarming figures in the Western Cape in South Africa (Morris & Parry, 2006). In Cape Town a dramatic increase in treatment admissions for adolescent methamphetamine abuse occurred between 2004 and 2006 (Pluddeman *et al.*, 2008) - approximately 200,000 (7% of the population) are estimated to be abusers of methamphetamine.

In 2005, 45% of patients receiving drug treatment in Cape Town (Figure 2) were using methamphetamine, making it the main drug of abuse reported at treatment centers (Morris & Parry, 2006). While high levels of use have been recorded among Coloured women, an increasing trend in use has been observed among Black women in Cape Town (Wechsberg *et al.*, 2008).



Figure 2: City of Cape Town (Google Maps, 2013)

CHAPTER 2: LITERATURE REVIEW

The use of methamphetamine results in serious physiological and psychological effects that are pertinent to the dental profession. The drug is highly addictive and acts as a stimulant for the central nervous system and leads to serious health effects such as premature labour, birth defects, memory loss, aggression, psychotic behavior and potential heart and brain damage. It also has devastating effects on oral health (Goodchild & Donaldson, 2007). It can be snorted, smoked, swallowed or injected and the drug's effects can be experienced within 20 minutes (Schepers *et al.*, 2003). This review aims to document the effects of methamphetamine on the oral cavity.

The number of methamphetamine users is estimated at 35 million worldwide (Hamamoto & Rhodus, 2009). From 1992 to 2002 admissions for treatment of methamphetamine abuse increased more than 500% in the US (Lineberry & Bostwick, 2006).

The South African Community Epidemiology Network on Drug Use (SACENDU) is a sentinel surveillance project operational in all nine provinces and monitors alcohol and drug use on a 6-monthly basis. The proportion for methamphetamine being the most common primary drug of addiction has dropped since 2009 (41% to 34%). Regarding the proportion of patients that are 20 years and younger, a decrease was observed from 51% to 48% for the period 2009 – 2010 (Pluddeman & Parry, 2010). In the Western Cape, a third of all patients in treatment rehabilitation centres reported using methamphetamine as the primary substance of abuse (Dada *et al.*, 2013).

2.1 Risk factors associated with methamphetamine use

General risk factors for methamphetamine abuse include unstable family environment; psychiatric conditions (Kosten & Owens, 2005) and history of violence (Russell *et al.*, 2008). Weight loss could be a factor in female use of methamphetamine, while increased libido and sexual performance is considered a motivating factor for males (Buxton & Dove, 2008).

Methamphetamine is also used as a coping strategy by homeless street youth, since it acts as an appetite suppressant, enables them to cope with negative emotions and helps them to stay awake to protect their belongings (Buxton & Dove, 2008). This is of particular relevance to the socially disadvantaged youth in the Western Cape.

2.2 General effects

Use of methamphetamine leads to increased energy, a sense of enhanced physical prowess, mental alertness, euphoria and mood elevation. Dehydration occurs due to elevated metabolism and increased physical activity. It also acts as an appetite suppressant (Shaner, 2002).

2.3 Physiological effects

The chemical structure is very similar to dopamine and norepinephrine as it causes the release of these neurotransmitters into the synaptic cleft (Goodchild & Donaldson, 2007; Shaner, 2002). The duration of action of methamphetamine is generally 8–12 hours but can be up to 24 hours during intoxication (O'Brien & Gardner, 2005). Dehydration occurs due to an elevated metabolism and increased physical activity. The drug also acts as an appetite suppressant. Abuse of the drug causes significant morbidity including fatal kidney and lung disorders, hyperthermia, stroke and cardiac arrest (Shaner, 2002). It also has an anorexic effect (Goodchild & Donaldson, 2007; Shaner, 2002) and causes unexplained motor activity and skin lesions (Richards & Brofeldt, 2000).

2.4 Behavioural effects

Users display violent, aggressive and paranoid behaviour during times of using methamphetamine (Richards & Brofeldt, 2000) and loss of interest in personal hygiene (Shaner, 2002).

According to the proposed 'gate-way hypothesis' by Kandel *et al.*, (1992) the progression to illegal substance usage among males is dependent on prior alcohol consumption and in females the use of either usage of cigarettes or alcohol is an

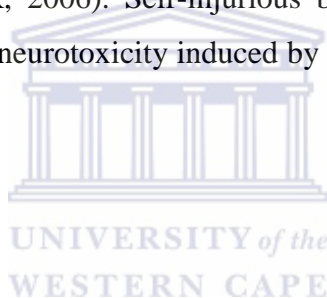
adequate condition for progression to marijuana. Other strong predictors of further progressions are the young age of onset and frequency of use (Yen *et al.*, 2005).

Methamphetamine users have a higher tendency of consuming large amounts of carbonated beverages with sugar and tobacco compared to non-users (Morio *et al.*, 2008).

A significant association between methamphetamine use and sexual risk behaviour was found (Pluddeman *et al.*, 2008a) in which it was consistently associated with HIV risk behaviours, indicating a high vulnerability to HIV infection.

Skin lesions formation are due to compulsive picking or “tweaking” at “meth bugs” resulting from methamphetamine-induced delusional parasitosis (Buxton & Dove, 2008; Lineberry & Bostwick, 2006). Self-injurious behaviour is considered as an indication of the long-lasting neurotoxicity induced by methamphetamine (Kita *et al.*, 2008).

2.5 Psychological effects



Methamphetamine is highly psychologically addictive (Heng *et al.*, 2008; Shaner, 2002) leading to severe depression and suicidal tendencies during withdrawal, with permanent psychological problems resembling paranoid schizophrenia (Shaner, 2002).

Users of methamphetamine are particularly at risk for developing a state of psychosis (McKetin *et al.*, 2006). Users display violent, aggressive and paranoid behaviour (Richards & Brofeldt, 2000; Shaner, 2002) and loss of interest in personal hygiene (Shaner, 2002).

Methamphetamine increases sympathetic activity in the central nervous system, causing a reduction in saliva secretion by stimulation of inhibitory alpha-2 receptors resulting in reduction in salivary secretion (Goodchild & Donaldson, 2007).

2.6 Neurological effects

The structural brain changes due to methamphetamine abuse are associated with acute and chronic cognitive impairments (e.g. recall and recognition) as well as emotional deficits (e.g. depression, psychotic symptoms and anxiety). Only partial improvement occurs with abstinence (Wang *et al.*, 2004). Neurotoxicity and nervous system degeneration are associated with long-term use of methamphetamine (Russell *et al.*, 2008).

2.7 Treatment of methamphetamine addiction

Cognitive-behaviour therapy and contingency management are two psychological interventions considered effective in the reduction of methamphetamine use (Lee & Rawson, 2008). The Matrix model also produced good results during treatment. However these approaches have failed to show long-term benefits (Buxton & Dove, 2008).

The aim is to protect the brain from the adverse effects of long-term methamphetamine use. Vaccines could facilitate recovery from addiction by providing long-lasting protection from the rewarding and reinforcing effects of the drug (Gentry *et al.*, 2009; Kosten & Owens, 2005).

2.8 Effects on the oral cavity

The clinical picture of methamphetamine abuse (Figures 3 – 7) includes generalized caries, periodontal disease, mucosal dysplasia, xerostomia, tooth wear and tooth loss (Goodchild & Donaldson, 2007).



Figure 3: Close-up anterior view maxillary and mandibular incisors



Figure 4: Right lateral view of maxillary and mandibular molars



Figure 5: Left lateral view of the maxillary and mandibular molars



Figure 6: Occlusal view of the maxillary arch



Figure 7: Occlusal view of the mandibular arch

Methamphetamine users have more decayed and missing teeth compared to non-users (Cunningham *et al.*, 2011). The drug may lead to poor oral hygiene, xerostomia (dry mouth), severe adverse effects on hard and soft intra oral structures and pathological changes. Rampant caries caused by high sugar intake due to increased consumption of soft drinks in the absence of protective saliva is observed in patients who abuse methamphetamine (Shaner, 2002; Klasser & Epstein, 2006; Morio *et al.*, 2008 Goodchild & Donaldson, 2007). Methamphetamine-related dental destruction may be due to a number of interacting factors, namely, rampant decay, the acidity of the drug, hyposalivation, an increase in consumption of sugar-containing beverages, poor oral hygiene and bruxism (Goodchild *et al.*, 2007). Bruxism as a result of drug-induced

hyperactivity causes accelerated tooth wear (Goodchild & Donaldson, 2007). Other symptoms are temporomandibular joint (TMJ) disorders, myofacial pain and trismus (Heng *et al.*, 2008).

A specific caries pattern known as “Meth Mouth” is observed in patients who abuse methamphetamine (Figure 8). The buccal smooth surfaces at the cemento-enamel junction and interproximal surfaces of anterior teeth are affected (Shaner, 2002). Teeth are darkly stained and crumbled (Heng *et al.*, 2008). Users have a higher percentage of anterior teeth, premolars and molars with decay than non-users (Morio *et al.*, 2008). The cementum is less resistant to demineralization than enamel; therefore, caries starts at the cemento-enamel junction (CEJ) and undermines the whole tooth leading to Class V caries in users of methamphetamine (Heng *et al.*, 2008). Typically, decay occurs on the facial and cervical areas of both the maxillary and mandibular teeth with eventual progression to frank coronal involvement (Goodchild & Donaldson, 2007).



Figure 8: “Meth Mouth”

Users who snort methamphetamine have significantly higher tooth wear in the anterior maxillary teeth than those who inject, smoke or ingest the drug. Distinct patterns of wear based on the route of administration have been observed. Chronic vasoconstriction of the arteries supplying the anterior maxillary teeth from frequent methamphetamine snorting potentially leads to decreased arterial blood supply to this region (Richards & Brofeldt, 2000).

It is understood that smoked methamphetamine containing phosphoric, sulfuric, or muriatic acid will bathe the teeth in acid and contribute to enamel erosion and breakdown (Goodchild & Donaldson, 2007). Rampant caries and tooth fracture leads to excessive tooth wear, multiple tooth loss and edentulism (Hamamoto & Rhodus, 2009).

2.9 Meth Mouth symptoms

The sympathomimetic effect of methamphetamine causes the inhibition on saliva secretion which leads to a dry mouth called xerostomia. The alpha-adrenergic receptors of the vasculature in salivary glands are stimulated and lead to vasoconstriction of blood vessels which causes a reduction in saliva secretion (Shaner, 2002). Xerostomia (Goodchild & Donaldson, 2007; Hamamoto & Rhodus, 2009; Shaner, 2002) contributes to inflammation and other fungal infections, such as candidiasis, cheilitis and glossitis (Heng *et al.*, 2008). The patient is at an increased risk of dental caries due to a reduction in saliva secretion (Macknelly & Day, 2009). Difficulty with mechanical cleaning of the mouth and a decrease in salivary antimicrobial protein may follow xerostomia. Speaking and swallowing food can become extremely difficult and the patient is more susceptible to oral disease with accompanying unpleasant tastes and burning mouth symptoms (Vidović Juras *et al.*, 2010). Food intake can also be adversely affected by a sore mouth (Macknelly & Day, 2009).

Methamphetamine users are prone to consume large amounts of soft drinks, to quench their thirst, and food containing high sugar levels to maintain high energy levels (Brand *et al.*, 2008; Shekarchizadeh, 2013). The cariogenic properties of soft drinks can be explained by the high levels of sugar which are broken down by intra-oral bacteria (Richards & Brofeldt, 2000). Poor oral hygiene causes plaque to accumulate and then bacteria continue to metabolize the sugar into acids causing demineralization of tooth structure (Heng *et al.*, 2008). During periods of high intake of soft drinks and sweet food, the oral pH level drops below the critical oral pH point (5.5) and erosion and decay of tooth structure usually follows (Grobler, 2011).

2.10 Oral health management

Research results from case-control studies indicated that the oral health status of methamphetamine users were worse than that of non-users. Recognition of the symptoms of “Meth Mouth” (association of rampant caries with methamphetamine abuse) can enable the clinician to identify such drug abuse (Shaner, 2002). The unusual caries appearance (multiple cervical cavities) should alert the clinician to the fact that the patient may be abusing methamphetamine.

The patient should be referred to a physician or substance abuse rehabilitation centre. Furthermore, dentists may be instrumental in identifying the oral signs and symptoms associated with methamphetamine abuse (Goodchild *et al.*, 2007). Therefore they need to be aware of the clinical presentation and medical signs presented by patients who are methamphetamine users (Hamamoto & Rhodus, 2009).

The approach to oral health management needs to be multidisciplinary with specific emphasis on prevention, promotion, restoring teeth and restoring/improving salivary gland function. Regular oral health instruction and education in combination with a determination of patient adherence and participation will shape the core oral health management plan for patients who have a history of methamphetamine addiction (Hamamoto & Rhodus, 2009). The main objective of treatment is to reduce development and progression of dental caries and improve salivary flow. It could also be beneficial for the patient to consult a dietician because the literature suggests that methamphetamine addicts develop a craving for consumption of soft drinks and are known for having a poor appetite which may lead to malnutrition and dietary insufficiencies (Hamamoto & Rhodus, 2009).

2.10.1 Diet and oral hygiene habits

The most important aspect of management is to encourage the patient to stop the habit of using methamphetamine. They need to be informed that the continued use of the drug will result in severe dental as well as neurological and other complications that will be difficult to treat. Patients need to be informed that the consumption of

carbonated drinks and food containing high levels of sugar should be reduced immediately. Improved oral hygiene and a balanced diet will also contribute to the dental rehabilitation. Patients need to be encouraged to actively take care of their oral health i.e. brushing twice per day with a soft tooth brush, flossing on a regular basis and to make use of a fluoridated tooth paste (Macknelly & Day, 2009).

2.10.2 Fluoride

Regular fluoride applications are essential to reduce dental caries progression. Oral rinses containing low levels of fluoride that do not require prescription may not be sufficient and professionally applied fluoride is strongly advised. Due to the unpleasant taste of stannous fluoride, as well as the potential burning sensations it may cause in the patient with xerostomia, the preferred mouth rinse is a solution of sodium fluoride (Goodchild & Donaldson, 2007).

2.10.3 Xerostomia

Methamphetamine users are xerostomic and therefore the pH of the mouth remains acidic for longer periods. Being xerostomic, the buffering capacity of saliva is reduced (Heng *et al.*, 2008).

Saliva contains secretory IgA which is an essential component of the immunological defense mechanism in the oral cavity (Rhodus, 1997).

The patient should be advised to drink 8 to 10 glasses of water each day and should avoid the consumption of caffeine, tobacco and alcoholic beverages because of their diuretic effects (Rhodus and Bereuter, 2000). Patients should also be encouraged to rinse their mouths on a regular basis (every hour) with 0.9% saline solution which is available at pharmacies (Macknelly & Day, 2009).

Other options include salivary substitutes, oral moisturizers and artificial saliva. However, the active agent in these products (carboxymethylcellulose or hydroxymethylcellulose) does not improve the viscosity of saliva and their actions are

of short duration, resulting in only minor relief when compared to water (Rhodus, 1997). Saliva substitutes may decrease the dental plaque index as well as a lower risk of developing gingivitis and fungal infection (Montaldo *et al.*, 2010).

The pharmacological stimulation of the salivary glands by using Pilocarpine is another possible method to relieve xerostomia. Pilocarpine is an alkaloid, parasympathomimetic drug taken from the Pilocarpus plant and acts as a muscarinic-cholinergic agonist and it is responsible for the stimulation of smooth muscle and exocrine glands such as the minor and major salivary glands for increased saliva secretion (Macnelly & Day, 2009). Recommended dosages are ranging from 2.5 to 15mg, 2 to 6 times per day per os (Fox *et al.*, 1991).

Major salivary glands can also be treated with low intensity laser BTL2000 on multiple occasions. Significant results from a previous study revealed higher salivation activity as well as increased levels of IgA (Vidović Juras *et al.*, 2010).

2.10.4 Pain

Patients often seek dental care due to severe dental pain. They experience pain between drug binges or after they have decided to stop methamphetamine abuse (Laslett & Crofts, 2007). A thorough history, examination of the source of the main complaint as well as the present oral status is essential during oral examination (Hamamoto & Rhodus, 2009). Local anaesthetics containing vasoconstrictors should be avoided in the case of a patient who took methamphetamine less than 24 hours prior to the dental visit as it may result in cardiac dysrhythmias, myocardial infarction, and cerebrovascular accidents (Turnipseed *et al.*, 2003; McGee *et al.*, 2004).

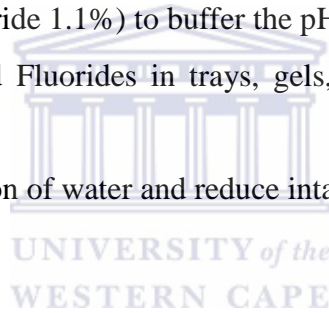
In addition, special caution also should be taken before prescribing medication to drug addicts due to potential harmful interactions in the case of a patient who is already using other drugs e.g. opioids. Health professionals should also not make use of prewritten prescription forms because methamphetamine users can demand on pain

medication when they refuse to receive clinical treatment. Non-steroidal anti-inflammatory drugs are safe to prescribe (Laslett & Crofts, 2007).

2.11 Preventive measures

In summary, the following preventive measures could be used (Goodchild & Donaldson, 2007):

- Stimulating saliva flow by means of pharmacologic agents
- Salivary substitutes
- Chewing sugarless gum (the simplest and most likely method to ensure client compliance).
- Oral moisturizers
- Increasing fluoride exposure to the oral cavity by administering a neutral fluoride (Sodium fluoride 1.1%) to buffer the pH and aid in caries prevention.
- Professionally applied Fluorides in trays, gels, rinses or varnishes could be used
- Increasing consumption of water and reduce intake of sugary drinks



CHAPTER 3: AIM & OBJECTIVES

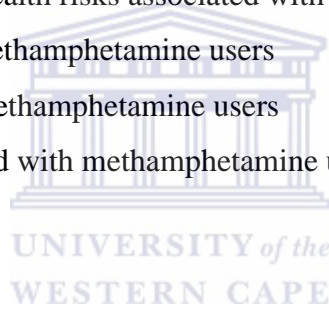
3.1 Aim

The aim of the study was to determine the oral health status of individuals using methamphetamine

3.2 Objectives

To determine the:

1. Demography of methamphetamine users
2. History of methamphetamine use
3. Dietary habits of methamphetamine users
4. Perception of the oral health risks associated with drug abuse
5. Dental caries status of methamphetamine users
6. Brushing frequency of methamphetamine users
7. Oral symptoms associated with methamphetamine use



CHAPTER 4: MATERIAL & METHODS

The present study utilized two instruments. Firstly, a researcher-administered questionnaire was used to elicit demographic information, history of drug use, medical history and dental history and secondly a data capture sheet was used following the clinical examination of the oral cavity to determine the dental caries status and treatment needs.

4.1 Study design

The study design was cross-sectional and descriptive in nature.

4.2 Study sites

Twenty two (22) substance abuse centres in the Western Cape (Figure 2) were included in the study.

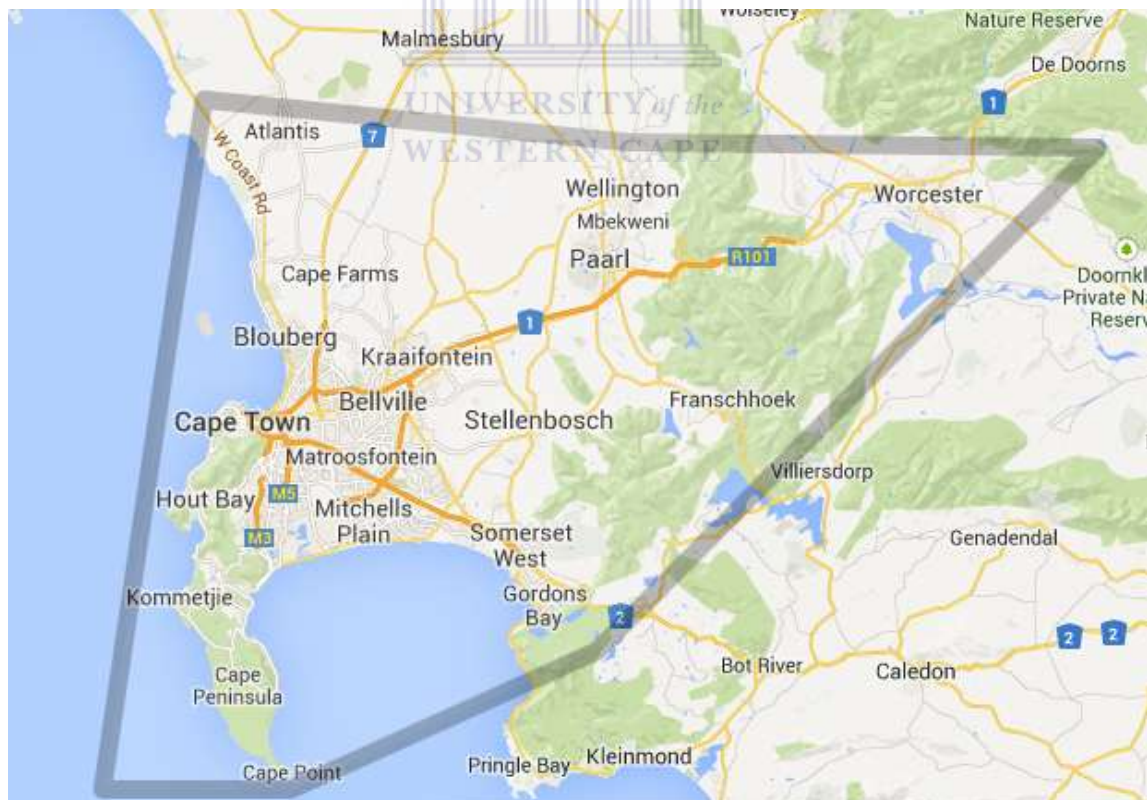


Figure 9: Geographical area of treatment centres (Google Maps, 2013)

4.3 Study population

The study population consisted of individuals who were using methamphetamine as a primary substance of abuse and who were in a treatment programme at a substance abuse treatment centre in the Western Cape.

4.4 Study sample

A convenience sample (n = 308) of methamphetamine users were included in the study.

4.5 Instrument

A structured researcher administered questionnaire was used to collect data on demographic information, history of drug use, diet and dental history (Appendix 1). Oral health symptoms during drug use such as grinding teeth, tooth ache, stiff facial muscles, sore gums, burning mouth and dry mouth were also investigated.

An intra-oral clinical examination was performed to measure the dental caries status (Decayed, Missing and Filled Teeth) and to determine treatment needs. The WHO Oral Health Survey guidelines and criteria for determining DMFT were used (WHO, 2013). The oral examination was carried out using a plane mirror and dental curved probe, no radiographic examinations were performed. Supplies and the examination area at each treatment centre adhered to the requirements initiated by the World Health Organization (WHO, 2013).

Information on the Decayed, Missing and Filled Teeth Index (DMFT) was captured on a data capture sheet (Appendix 2). The D-component included all teeth with codes 1 or 2. The M-component included teeth coded 4 in patients under 30 years of age and the teeth coded 4 or 5 for patients who are 30 years and older, i.e. missing due to caries or for any other reason. The F-component included only teeth with code 3. Teeth coded 6 (fissure sealants) or 7 (bridge abutment, special crown or veneer/implant) were not included in calculation of the DMFT.

DMFT index was calculated by dividing the total number of decayed, missing and filled teeth by 28.

4.5.1 Developing the study questionnaire

A pilot study was conducted to test the questionnaire in terms of practicability and relevance. A convenience sample was selected (n=15) from patients who were self-reported methamphetamine users who presented at the Tygerberg Oral Health Centre and the Out-Patient Department of Stikland Psychiatric Hospital.

The pilot study was carried out to:

1. test the suitability of the method of collecting the data
2. test how long each examination will take to complete
3. check the adequacy of the data capture sheet
4. check that all the parameter measurements are clear and unambiguous
5. ensure that no major item has been omitted
6. remove any items that do not yield usable data

4.5.2 Preparation for the final draft

After the pilot study, irrelevant and problematic items were identified and deleted or reformulated. A final draft of the questionnaire was then printed and used for the final study sample.

4.6 Data collection

Information was retrieved from the completed questionnaires and transferred to a spread sheet in Microsoft Excel 2010. The collected data was categorized, coded and entered into the computer.

4.7 Validity

Control for confounding variables was taken into consideration by including the medical history and medication of participants. Users who were on medication that could lead to a dry mouth were excluded from the study.

The author was the only investigator involved in the gathering of data. Interpretation of data and statistical analysis was done by the author and an independent statistician. To ensure validity, the questionnaire was subjected to a test-retest procedure.

4.8 Reliability

Prior to measurement, the investigator was calibrated by two independent researchers to ensure uniformity of the oral examination. A kappa statistic of 0.873 was obtained, indicating good agreement (Appendix 3).

4.9 Data analysis

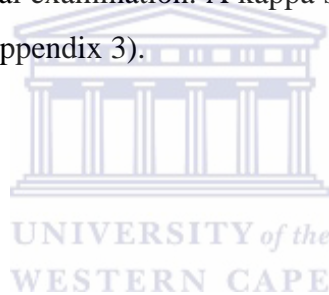
4.9.1 Description

A basic descriptive analysis was done using the Microsoft Excel and Epi Info (version 7). The database was imported into Epi Info 7 ® and R ® to perform more complex statistical analyses.

The independent t-test was used to determine the association between variables. The Mann-Whitney U test was used to determine the association between nominal and ordinal variables. Chi-square tests were used for other associations. Statistical level significance was set at $p < 0.05$.

4.10 Establishing contacts

Access to the participants of the study was made initially by a letter to each treatment facility manager (Appendix 4). An introduction of the researcher, the basic aims and objectives of the study, what participating in the study would involve and how long



the examination and questionnaire would take were explained. It was emphasized that that strict confidentiality would be maintained at all times and that the results of the study would be presented in a manner that ensured anonymity. Once signed informed consent (Appendix 5) was received from each participant, appointments were made and the patients interviewed and examined.

4.11 Ethical considerations

The research proposal was approved by the Senate Research Ethics Committee of the University of the Western Cape on the 23rd of July 2010 (ID number: 10/05/17). Further research approval was also obtained from the Western Cape Department of Social Development on the 30th November 2012 (ID number: 9/2/114/3/2/4) and The City of Cape Town on the 12th of December 2012 (ID number: 10331). Participation was voluntary and anonymous and signed informed consent was obtained from each patient. Anonymity was secured by not using the participant's names on the questionnaire and the questionnaire was recorded with reference codes. A separate consent form (Appendix 6) was signed if photographs were taken. Interviews and oral examinations took place in a private room at the treatment centre.

4.11.1 Collaborative partnership

In order to obtain access to the selected participants a good relationship was established between the principal investigator and the directors of the various treatment centres. Meetings with the director of each substance abuse centre prior to participant selection ensured a level of trust and consideration. During these meetings the study was explained in detail regarding the objectives, aim and methodology. An opportunity was created for questions to be asked and to ensure proper understanding of the study.

4.11.2 Social value

Beneficiaries of the research were firstly the participants who received a free dental consultation by a qualified dentist that included essential oral health education and instructions.

By incorporating oral health services into their existing programme, drug addiction centres can benefit from the study being able to provide more comprehensive care to their clients.

4.11.3 Informed consent

Signed informed consent has been obtained from all participants after they were fully informed of the aim, objectives and methodology of the study. Participants were able to ask questions and were informed that they could withdraw from the study at any stage during the interview and examination.



CHAPTER 5: RESULTS

This chapter reports on the findings of a cross-sectional study that investigated the oral health status of methamphetamine users involved in a treatment programme. Self-reported data was collected on demography, history of abuse, dietary habits, oral health symptoms which were experienced during abuse and brushing frequency. Clinical examination provided information on dental status and treatment needs and the association between DMFT and duration of addiction.

5.1 Response rate

Twenty two (22) substance abuse treatment centres were visited and the sample size was 308 participants. More than a quarter of the sample (26.62%) was from centres in the Tygerberg sub-district of the City of Cape Town and 22.4% from centres outside the borders of the City of Cape Town.

5.2 Demographic information

5.2.1 Gender

The majority of the sample was male (69%).

5.2.2 Age distribution

The mean age of the sample was 27 (SD = 6.7) years. The median for age was also 27 indicating that age was normally distributed. The inter quartile range for age was 22 – 30. Half were aged between 21 – 29 years old (Figure 10).

The mean age of male users was 26 year and for female users the mean age was 28 years, with no statistical significant difference ($p = 0.09$). The youngest user in the study was a 15 year boy and the oldest, 48 years old.



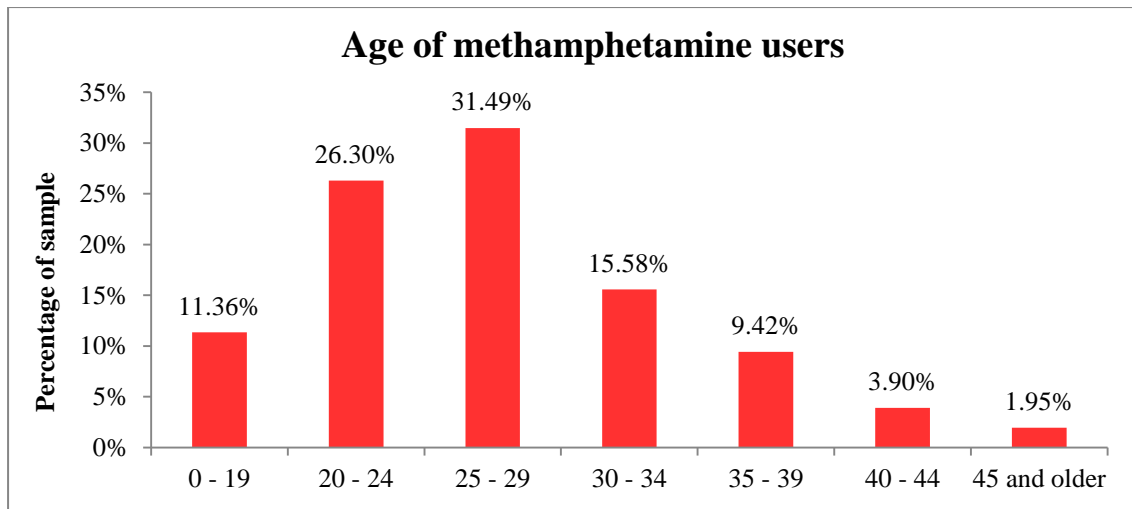


Figure 10: Categorical age distribution of study sample

5.2.3 Employment status

The unemployment rate was 71.57% and the mean duration of unemployment was 21 months. The most common occupations were craft and trade workers, service and sales workers and elementary occupations.

5.2.4 Level of education

Only a fifth (20%) had received tertiary education. The majority (72.40%) of users indicated high school and 6.17% primary school as the highest level of education (Figure 11).

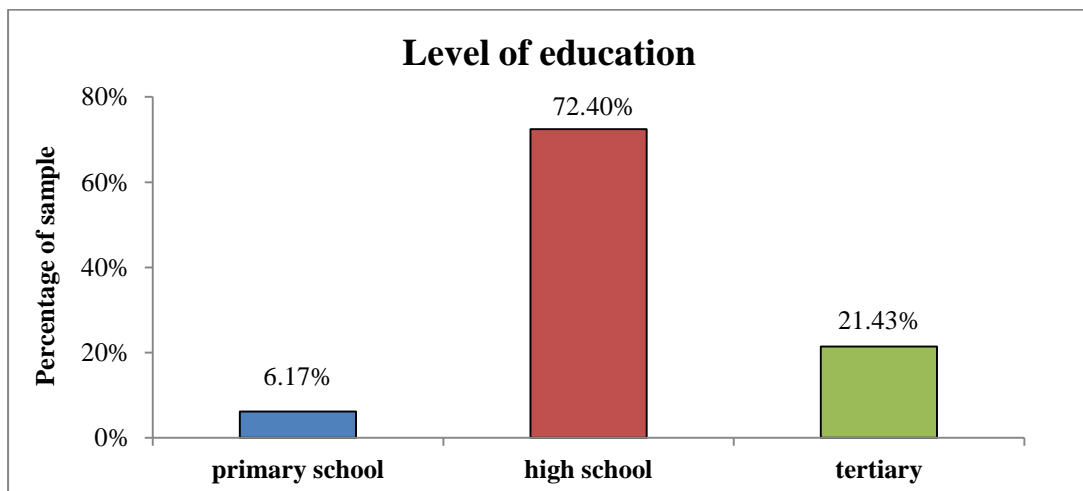


Figure 11: Highest level of education reached

5.2.5 Other demographic information

More than half of the sample had children (58.5%) with a mean of two children per person. Almost half (45%) of all females who were mothers was pregnant before the age of 20. The majority (85%) were not married on the day of the interview.

5.3 Drug abuse history

5.3.1 Age at first use

A third of the sample reported that they were 16 years and younger when they started using methamphetamine. The mean age at first usage of methamphetamine among the entire sample was 20 (SD = 6.5) years old. There was a significant difference ($p = 0.02$) between males and females with regards to age of first usage (males started at the age of 19 years, females at age 21 years).

5.3.2 Duration of drug addiction

The mean duration of drug addiction was approximately 6.5 (SD = 3.1) years. The mode for duration of addiction was 7 years. More than two thirds used the drug for more than 4 years (Table 1).

Table 1: Categories of duration of addiction

DURATION OF ADDICTION	n	%
0 – 4 years	98	31.82
5 – 8 years	131	42.53
More than 8 years	79	25.65
Total	308	100.00

5.3.3 Frequency of drug use

The majority of the sample reported using methamphetamine on either a daily (73.38%) or a weekly (23.38%) basis (Table 2).

Table 2: Frequency of drug use

FREQUENCY OF DRUG USE	n	%
Everyday	226	73.38
Weekly	72	23.38
Monthly	10	3.25
Total	308	100.00

5.3.4 Method of drug use

The majority (93%) of the sample reported smoking as the primary method of using methamphetamine. Ten patients (3.25%) reported of snorting the drug, nine (2.92%) drank it and one person (0.32%) injected the drug (Table 3).

Over 60% indicated that they were using methamphetamine with others.

Table 3: Method of usage

METHOD OF USAGE	n	%
Smoke	288	93.51
Snort	10	3.25
Drink	9	2.92
Inject	1	0.32
Total	308	100.00

5.3.5 Number of days since the last usage (abstinence)

The mean duration since last usage was 70.33 days. About 12% indicated that they had not used methamphetamine in the past 21 days.

5.3.6 Daily expenditure

The average daily expenditure on methamphetamine per person was R166.30 and there was no significant difference between users who were employed and those who were unemployed ($p = 0.44$).

5.3.7 Participant's first introduction of the name "Tik" (methamphetamine)

The majority (70.45%) of participants reported that they were informed about "Tik/methamphetamine" for the first time from friends and 16.23% heard about it from family (Table 4).

Table 4: First introduction of the word: "Methamphetamine or Tik"

WHERE DID YOU HEAR OF TIK FOR THE FIRST TIME?	n	%
Radio	1	0.32
University	1	0.32
Newspaper	6	1.95
TV	7	2.27
Other	10	3.25
School	16	5.19
Family	50	16.23
Friends	217	70.45
Total	308	100.00

5.3.8 Reasons for using methamphetamine

The majority (61.12%) reported that "experimenting" was the reason for first using the drug. Peer pressure (17.28%), home issues/problems (9.3%), emotional trauma/problems (4.32%) and being in a relationship with a methamphetamine user

(2.66%) were other reasons. Five (1.62%) users reported that they started using the drug to lose weight.

5.4 Dietary habits

5.4.1 Drinks and food types preferred

Nearly two thirds (59.09%) reported consuming large amounts (2 – 6 l/day) of soft drinks and 45.78% consumed alcohol drinks while using the drug. More than half of the sample also drank water (55.19%) because it was free and quenched the severe thirst after using the drug.

“Food” consisted mainly of chocolates and sweets (18.18%) and “junk food” / take-away (15.58%). Other food consumed included crisps and salty snacks (13.31%), bread and pasta (12.99%), breakfast cereal & porridge (11.04%), and fruit and vegetables (9.42%). Some patients reported drinking yoghurt and dairy products (13.31%) as they were easy to swallow.

5.4.2 Appetite when using methamphetamine

The majority (80.2%) reported a poor or very poor appetite when using methamphetamine (Table 5).

Table 5: Appetite when using methamphetamine

APPETITE	n	%
Very good	1	0.32
Good	8	2.60
Normal	52	16.88
Poor	115	37.34
Very poor	132	42.86
Total	308	100.00

5.5 Perception of oral health risks associated with drug abuse

Nearly all (95.45%) agreed that methamphetamine can damage their teeth and the most common perception (28%) was that ‘teeth will break’ when using methamphetamine. Almost a fifth (19.31%) reported that it will “eat” the teeth and the rest of participants indicated that teeth will rot, become brittle or crack. Some mentioned that methamphetamine causes cavities and the acid in the drug will damage teeth.

5.6 Dental History

5.6.1 Perception on appearance and functionality of teeth

The majority (63.31%) of the sample were not satisfied with the *appearance* of their teeth, but more than half (53.57%) were satisfied with the *functioning* of their teeth.

5.6.2 Last dental visit

The majority (56.17%) reported that their last dental visit was more than a year ago and 27.27% reported visiting a dentist in the last 6 months (Table 6).

Table 6: Last dental visit

LAST DENTAL VISIT	n	%
In the last 6 months	84	27.27
About a year ago	40	12.99
More than a year ago	173	56.17
Never	11	3.57
Total	308	100.00

The most common reason for the last dental visit was due to a toothache (60.71%) (Table 7). The most common treatment received during their last dental visit was a

dental extraction (72.47%). Other procedures, such as restorations (fillings) (9.76%) and cleaning (8.71%) were less common (Figure 7).

Table 7: Reason for going to the dentist the last time

REASON FOR GOING TO DENTIST THE LAST TIME	n	%
Toothache	187	60.71
Check-up	26	8.44
Required fillings	21	6.81
Chipped teeth	16	5.19
Required cleaning	12	3.9
Required dentures	6	1.94
Bad breath	3	0.97
Skew teeth	3	0.97
Wisdom teeth	2	0.65
Loose teeth	1	0.32
No reason provided	31	10.06
Total	308	100.00

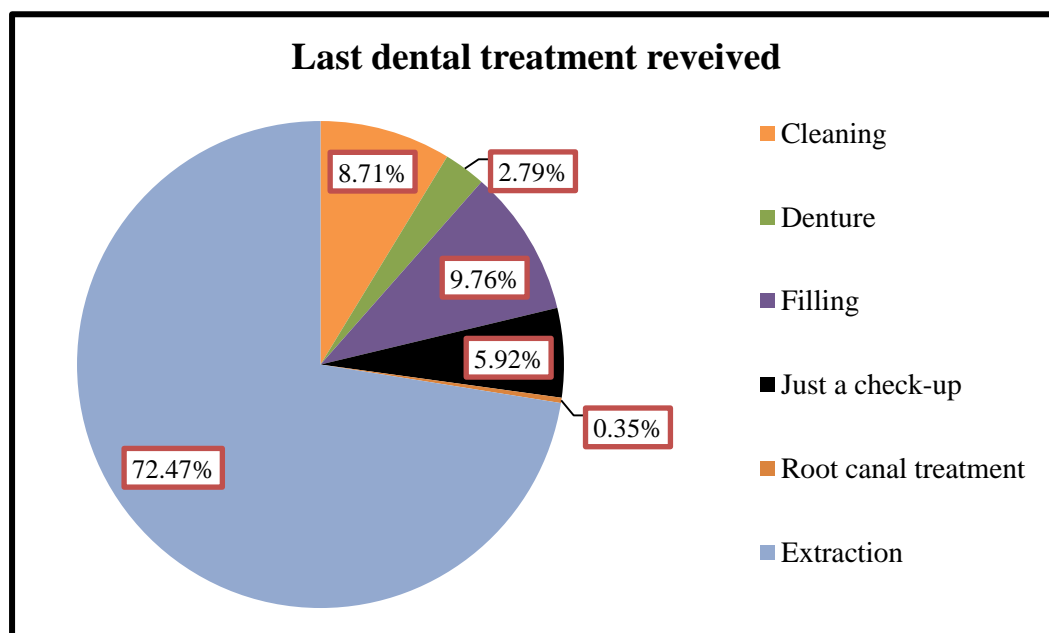


Figure 12: Last dental treatment received

5.6.3 Self-reported changes of teeth after period of abuse

The majority (82.74%) of the participants indicated that their teeth had changed since they have started using methamphetamine.

The majority of users reported that their teeth had broken (30.80%) and had become rotten (17.54%). A few users reported that their teeth had become weaker (3.79%) or/and chipped (3.79%).

Slightly less than 17% of users who had experienced a change in their teeth reported a change in colour. Two thirds of the users who reported tooth discoloration indicated that their teeth had stained yellow and 13.95% reported a brown discoloration (Table 8).

Table 8: Tooth discolouration among methamphetamine users

COLOUR	n	%
Yellow	29	67.44
Brown	6	13.95
Black	5	11.63
Blue	1	2.33
Off-white	1	2.33
White spots	1	2.33
Total	43	100.00

5.7 Oral health symptoms experienced during methamphetamine use

The majority of participants (93.51%) reported that they had a dry mouth and a bad taste in their mouth (91.23%) when using the drug (Figure 13). Almost three quarters (73.38%) reported stiff facial muscles and more than half (59.74%) said that they were grinding their teeth. Other symptoms that were less common included sore gums (33.44%) and a “burning” sensation in the mouth (21.1%). There was an association between grinding teeth and stiff facial muscles ($p = 0.00024$; $RR = 1.3$). Females were 1.5 times more likely to have sore gums compared to males (0.013).

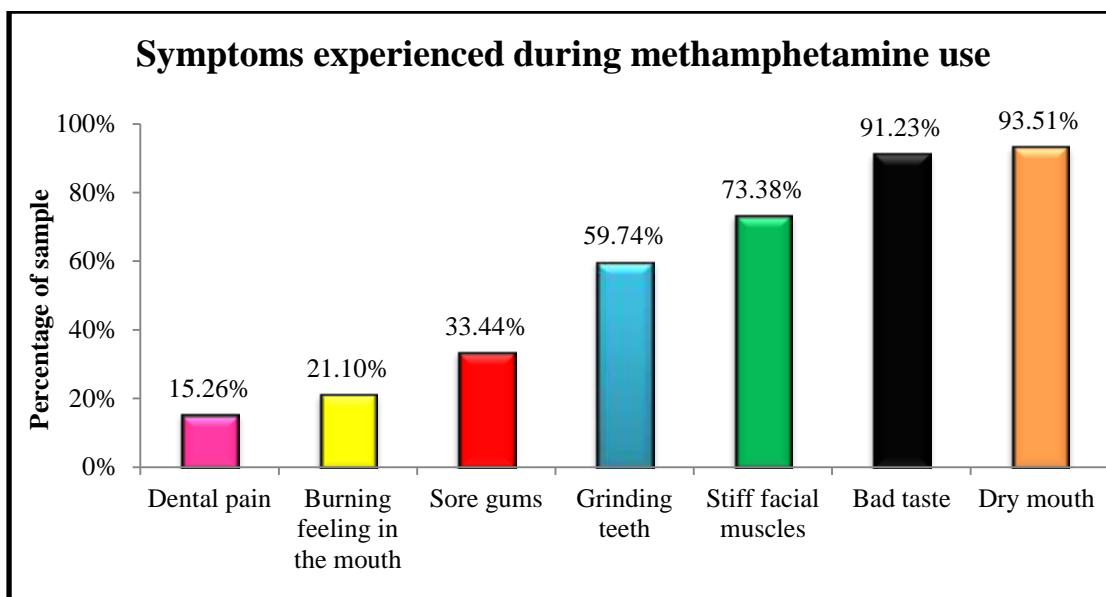


Figure 13: Oral symptoms experienced during usage of methamphetamine

5.8 Effect on saliva secretion

5.8.1 Duration from start using methamphetamine until experiencing a dry mouth

The majority (93.52%) indicated that the duration from the time they started using methamphetamine until they experienced a dry mouth was less than an hour. Almost a third reported that their mouth was dry within 5 minutes (Table 9).

Table 9: Time from using methamphetamine until experiencing a dry mouth

Time until dry mouth	All participants	Females	Males
≤ 5 minutes	30.72%	36.96%	27.86%
> 5 min ≤ 60 min	62.80%	54.35%	66.67%
> 1h ≤ 6 h's	5.80%	7.61%	4.98%
> 6 h's	0.68%	1.09%	0.50%
Total	100%	100.00%	100.00%

5.8.2 Time from the last dosage until the user experienced a normal salivated mouth

Three quarters of the sample indicated that the time for their mouth to return to 'normal' again after the last dosage of methamphetamine was 5 minutes to 1 hour (Table 10).

Table 10: Time from last dosage until experience normal salivated mouth

Time until normal	All participants	Females	Males
> 0 ≤ 60 min	6.14%	10.87%	3.98%
> 1 ≤ 24h's	77.82%	75.00%	79.10%
> 1 ≤ 7 days	14.33%	11.96%	15.42%
> week	1.71%	2.17%	1.49%
Total	100%	100%	100%

5.9 Brushing frequency

Tooth brushing was regarded as frequent when occurring twice or more per day and infrequent when occurring once or less per day. The period when the individual were using methamphetamine was titled as “On Meth” and not using methamphetamine was “Off Meth” (Table 13).

5.9.1 Brushing frequency when not using methamphetamine

The majority (82.47%) of participants reported that they brushed their teeth either once or twice a day when not using methamphetamine. Almost half (48%) brushed their teeth frequently (Table 11).

Table 11: Brushing frequency when not using methamphetamine

TEETH BRUSHING FREQUENCY	n	%
Never	2	0.65
Less often	32	10.39
Once a day	126	40.91
Twice a day	128	41.56
More often	20	6.49
Total	308	100.00

5.9.2 Brushing frequency when using methamphetamine

Nearly half reported that they brushed their teeth less than once a day or never when using methamphetamine. Slightly more than a third (37.99%) of the sample were brushing their teeth frequently during stages of drug use (Table 12).

Table 12: Brushing frequency during drug use

BRUSHING FREQUENCY DURING DRUG USE	n	%
Never	17	5.52
Less often	110	35.71
Once a day	64	20.78
Twice a day	51	16.56
More often	66	21.43
Total	308	100.00

There was a significant difference in teeth brushing frequency when using methamphetamine (“On Meth”) compared to not using the drug (“Off Meth”) ($p = 0.0000022$; $\chi^2 = 23.84$). Only a quarter of the sample was brushing frequently during periods of “On Meth” and “Off Meth”. The majority (40%) of the sample was brushing infrequently irrespective of being “On” or “Off” the drug (Table 13).

Table 13: Brushing frequency during ‘Off’ and ‘On’ Meth use

		Off Meth		Total
		Frequent	Infrequent	
On Meth	Frequent	77	40	117
	Infrequent	71	120	191
TOTAL		148	160	308

5.10 Medical history

The majority (79.55%) was medically healthy and on no medication (82.79%). The most common self-reported medical condition was a “mental disorder” and nearly a quarter reported they were suffering from a respiratory condition (Table 14).

Table 14: Common categories of medical conditions

COMMON MEDICAL CONDITION (CATEGORY)	n	%
Mental	32	55.17
Respiratory	14	24.14
Cardiovascular	7	12.07
Metabolic	3	5.17
Auto-Immune	2	3.45
Total	58	100.00

Bipolar disorder and depression was the most common mental disorders among users of methamphetamine. Other mental disorders included depression, schizophrenia, anxiety, psychosis and ADHD (Table 15).

Table 15: Most common mental disorders among methamphetamine users

MENTAL DISORDERS	n	% of sample
Bipolar	11	3.57
Depression	9	2.92
Schizophrenia	7	2.27
Anxiety	3	0.97
Psychosis	3	0.97
ADHD	1	0.32

5.11 Dental Caries Status

Almost the entire sample (98.05%) was affected by dental caries and the mean DMFT score was 10 (Figure 14). Most users had 2 – 4 decayed teeth. The mode for DMFT was 8 and the mode for sound teeth was 19. Eight (2.6%) users were caries-free and one user had 21 decayed teeth. More than half of the sample (55.97%) had a DMFT score of 0 – 14. Almost a fifth of the sample had a DMFT score of 15 – 21 (Table 16). The majority of participants (90.58%) had a DMFT score of 4 and more (95% CI: 86.62% - 93.5%). The mean number of filled teeth was one and the mean number of missing teeth per person was five. Fourteen per cent (14%) of the sample had 10 and more teeth missing. Three users (1%) were completely edentulous. The mean number of decayed permanent teeth per patient was 5 and the majority of the sample (89.29%) had untreated decayed teeth (95% CI: 85.15% - 92.41%).

Table 16: DMFT-scores of methamphetamine users

DMFT	n	%	95% CI
0 – 7	101	32.79%	27.62% - 38.39%
8 – 14	133	43.18%	37.61% - 48.93%
15 – 21	61	19.81%	15.59% - 24.79%
>21	13	4.22%	15.59% - 24.49%
Total	308	100.00%	

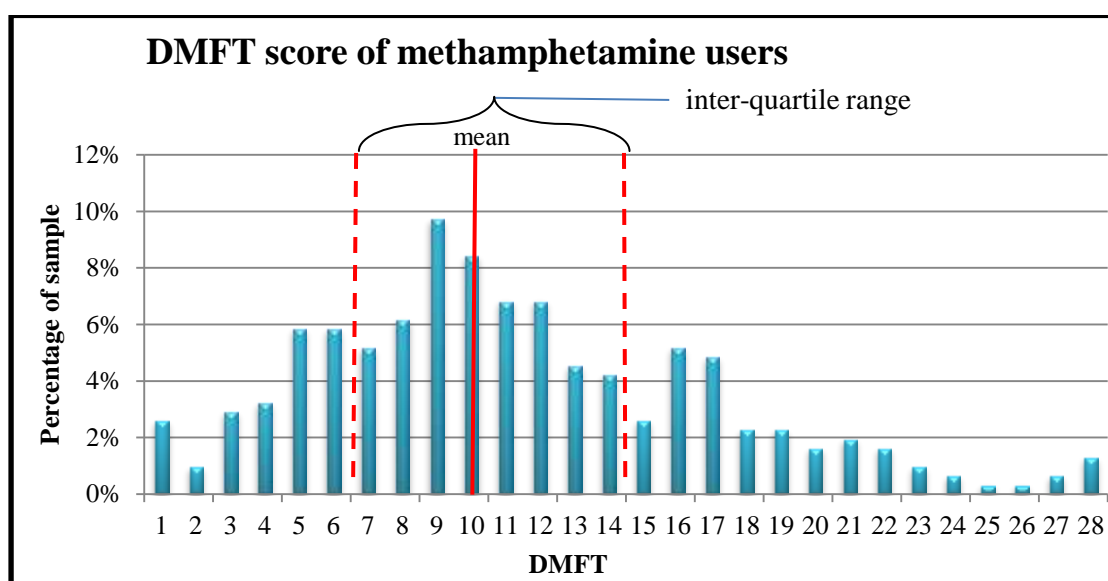


Figure 14: DMFT distribution of methamphetamine users

Table 17: Dental status of methamphetamine users

	Mean	SD
Decayed Teeth	5	3.71
Filled Teeth	1	2.04
Missing Teeth	4	4.92
DMFT	10	5.87

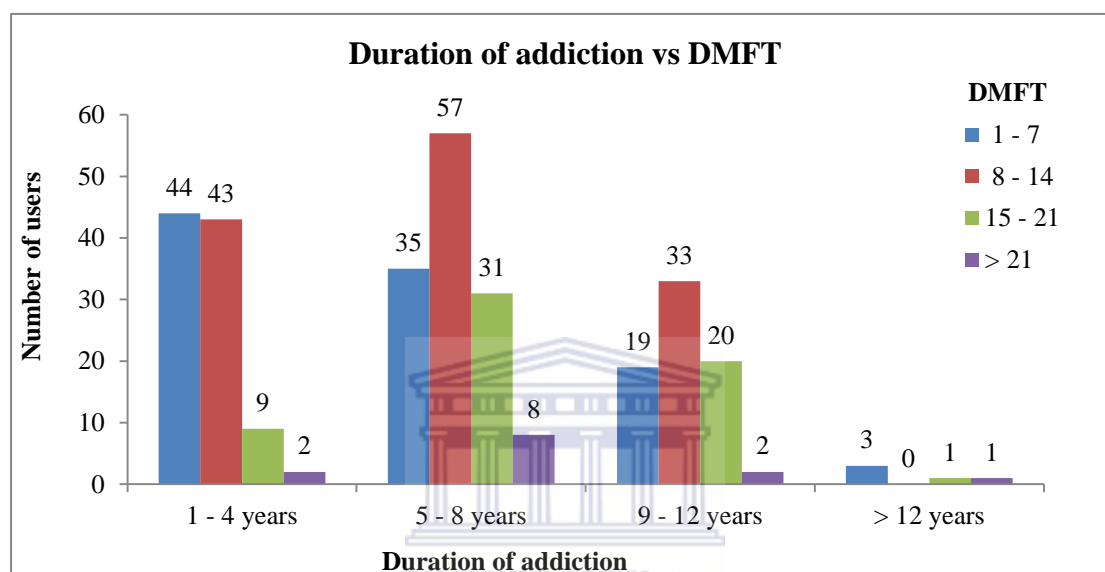


Figure 15: DMFT and duration of addiction

Table 18: Duration of addiction vs DMFT

Duration of addiction	n	Mean DMFT	Variance	SD	%
1 - 4 years	98	8.52	23.86	4.88	31.82
5 - 8 years	131	11.26	37.12	6.09	42.53
9 - 12 years	74	11.01	33.68	5.80	24.03
> 12 years	5	11.2	128.7	11.34	1.62
Total	308	10			

There was an association between mean DMFT and duration of addiction ($p = 0.003$). Users who were using methamphetamine for the shortest duration of time had a lower DMF score of 8 compared to those who were using methamphetamine for longer than 4 years who had a DMF score of 11.

Users who were using methamphetamine for the shortest duration of time had less teeth decayed (3) compared to those who were using methamphetamine for longer than 4 years who each had 5 teeth decayed.

The association was less significant when mean number of missing teeth and duration of drug addiction was compared ($p = 0.04$). Users who were using methamphetamine for the shortest duration of time, had less teeth missing (3) compared to those who were using methamphetamine for longer than 4 years who had 5 teeth missing each.

5.12 Dental treatment required after clinical examination

The most common dental treatment required was extraction. One fifth of the sample required at least 1 extraction while 13% required at least two extractions. The mean number of extractions required per user was 2 teeth. One user, who was smoking methamphetamine for 13 years, required 19 extractions.

The highest level of education which was achieved by users was associated with the least number of extractions which were required ($p = 0.003$). There was a significant ($p\text{-value} = 0.005517$) difference observed between the education groups with regards to the number of extractions that were required. Figure 16 is a plot of mean number extractions required against level of education. Users who reached tertiary level of education were significantly different in terms of number of extractions which were required compared to those who reached high school. Users who reached primary school compared to those who reached high school were marginally different.

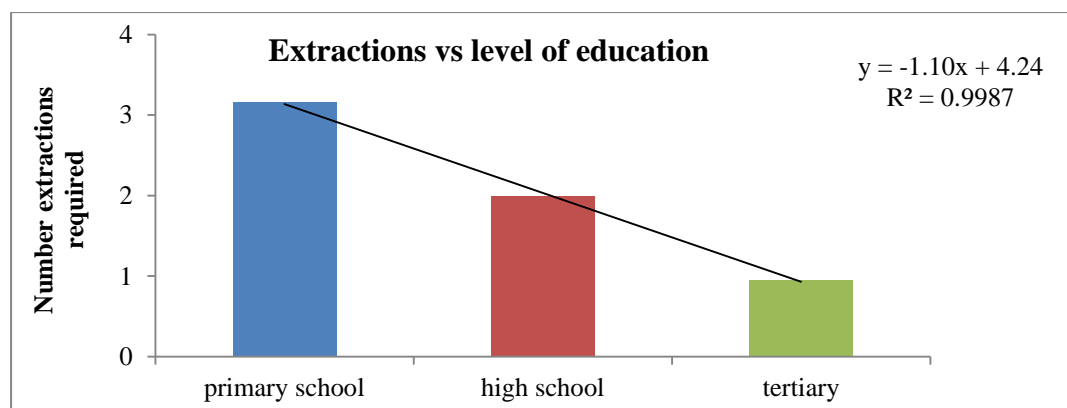


Figure 16: Extractions required according to level education

5.13 Summary

The most prominent findings from the study were that most users are male, unemployed and the mean age was 28. The mean DMFT score was 10 and the last dental visit was more than a year ago. A dental extraction was the most common treatment required by users and the most common oral symptoms were a dry mouth and a bad taste in the mouth. Users were brushing less frequently when they were using methamphetamine compared to when they were not using the drug and tooth brushing frequency was associated with duration of addiction. The level of education was associated with number of extractions required. Half of all users, whom had a medical condition, reported having a mental disorder.



CHAPTER 6: DISCUSSION AND CONCLUSION

6.1 General

The purpose of the present study was to determine the impact of Methamphetamine abuse on oral health.

The present study found that methamphetamine users have serious health problems which include mental conditions, severe dental caries and extensive tooth loss. This concurs with other studies which had shown that methamphetamine has become a major problem in the United States (Rawson *et al.*, 2002; Roehr, 2005), South Africa (Morris & Parry, 2006), and within the Southeast Asia and Pacific region (Farrell *et al.*, 1992; Topp *et al.*, 2002).

6.2 Demographic information

The South African Community Epidemiology Network on Drug Use (SACENDU) is a sentinel surveillance project operational in all nine provinces and monitors alcohol and drug use on a 6-monthly basis. The present study reflects similar demographic characteristics as reported by SACENDU: the majority of users are male, unemployed and in the age group 25-29 years. These demographic characteristics are similar to studies carried out in Australia (McKetin, 2006) and in the United States (Shrem & Halkitis, 2008).

Poverty, unemployment and a lack of income are serious problems among methamphetamine users (Dada *et al.*, 2013). In the present study unemployment was 72%. Henkel (2011) found that unemployment was a risk factor for substance use and that the problematic use of illicit drugs can increase the risk of unemployment (Henkel, 2011).

In the present study, most of participants had reached high school but had not obtained a senior certificate. Low levels of education were associated with increased numbers of extractions and poor oral health.

6.3 History of abuse and habits

The finding that users were smoking the drug either on a daily basis or more regularly was consistent with the literature (Dada *et al.*, 2013; Mcketin *et al.*, 2006).

Nearly a fifth of the participants were introduced to the drug by their family whereas a study from the United States reported that only 10% of methamphetamine users were introduced to the drug by their family (United States Department of Justice, 1999).

6.4 Dietary habits and appetite

Studies have reported that most methamphetamine users have a poor appetite (Shaner, 2006) and their diet usually included large quantities of soft drinks and alcoholic beverages (Brand *et al.*, 2008; Shekarchizadeh *et al.*, 2013). The present study found similar dietary habits of frequent intake of carbonated drinks and a poor appetite.

6.5 DMFT and dental caries among methamphetamine users

The mean DMFT score of the sample was 10 and dental status worsened with increasing duration of the addiction. These findings are similar to those supported in the literature (Shetty *et al.*, 2010; Shaner, 2002; Klasser & Epstein, 2006; Morio *et al.*, 2008; Goodchild & Donaldson, 2007; Marshall, Qian, & Morgan, 2008; Cunningham, 2011).

6.6 Oral health status

Participants complained of the poor dental appearance and functioning caused by the deleterious effects of methamphetamine due to rampant caries and multiple tooth loss leading to edentulism.

The presentation of dental caries and demineralization patterns among study participants reflected the classical caries pattern of “Meth Mouth” (Hamamoto & Rhodus, 2009; Shaner, 2002). Cavities were found on buccal smooth surfaces and

interproximal areas of anterior teeth. Some researchers have reported that “Meth Mouth” appeared similar to the caries pattern observed in Sjogren’s syndrome (Rhodus & Little, 2005) and Early Childhood Caries (Shaner, 2002; Shaner *et al.*, 2006). “Meth Mouth” can be explained by the chronic dry mouth (Rhodus & Little, 2005; Shaner, 2006), inadequate brushing and high sugar consumption.

6.7 Oral health symptoms

The present study had found that a dry mouth was the most common symptom experienced by users and this concurs with the literature (McGrath & Chan, 2005; Shaner, 2002, Hamamoto & Rodus, 2008). Activation of alpha-adrenergic receptors lead to vasoconstriction of the vasculature of salivary glands and decreased saliva secretion (Saini *et al.*, 2005). An anticholinergic action causes a dry mouth which leads to difficulties with speaking and swallowing, an unpleasant taste sensation and burning mouth symptoms (Vidović Juras *et al.*, 2010). It also leads to a sore mouth (Macknelly & Day, 2009), an inflammatory response of intra-oral soft tissue and related fungal infections such as candidiasis, resulting in cheilitis and glossitis (Heng *et al.*, 2008). It was interesting to note that participants regarded a dry mouth as an indication of reaching a “high”. Most users reported that the time that elapsed from the last use of the drug until experiencing a ‘normal’ mouth was about 24 hours which concurred with literature (Lake & Quirk, 1984).

Another common symptom experienced by participants was grinding of teeth which is also consistent with other studies (Goodchild & Donaldson, 2007; Turkyilmaz, 2010; McGrath & Chan, 2005). A “bad taste in the mouth” while using methamphetamine was also reported but this finding could not be substantiated by other studies.

Although dental pain was not always prominent during times of methamphetamine usage, participants did indicate they often had episodes of tooth ache during abstinence and the severity of the pain resulted in relapsing by using methamphetamine to bring pain relief. Less common symptoms included stiff facial muscles and constant grinding of teeth, “burning” sensation in the mouth and sore gums.

6.8 Risk factors for dental destruction

The severe destruction of dentine and enamel can be explained by a chronic dry mouth, constant grinding of teeth and an increased consumption of carbonated soft drinks and snacks containing high levels of sugar and a poor appetite (Ravenel *et al.*, 2012). There is strong evidence to support the association between a dry mouth and risk for dental caries due to a decreased buffering effect (Garcia-Godoy & Hicks, 2008). Other contributing factors can be an increased metabolism and physical activity (Shaner, 2002; Goodchild & Donaldson, 2007).

6.9 Brushing frequency

Brushing frequency during “On” and “Off” Meth usage was significantly different and this finding was in contrast to Cunningham *et al.*, (2011) and Qian (2011). However these studies had significantly smaller sample sizes. Others have reported that methamphetamine users were found to rarely brush their teeth (Morio *et al.*, 2008) and experienced irregular periods of oral hygiene (Hamamoto & Rhodus, 2007) which is consistent with present study.

6.10 Frequency of dental visits and treatment history

Shetty *et al.* (2010) had found that methamphetamine users delay their dental visit until they have an acute episode of dental pain. This kind of behavior makes it very challenging to arrange follow-up visits with rehabilitative treatment and oral health promotion and education initiatives. In many instances, due to the high levels of dental destruction, complex restorative and surgical management is usually required to ensure complete oral rehabilitation of methamphetamine users. The present study found that users made infrequent dental visits and mainly for pain. Most users had their last dental visit more than a year ago and in most occasions, a dental extraction was the treatment received.

Another reason for non-attendance could be related to the fact that users may not have dental insurance and a fragmented oral health care system which cannot deliver basic oral health care may contribute to an increasing unmet need (Shetty *et al.*, 2010).

Furthermore, it has been reported that users often have financial constraints and are unable to afford complex dental treatments that may be required (Klasser & Epstein, 2005; Williams & Covington, 2006).

6.11 Medical history

Of those users who had an underlying medical condition, half of them reported having a mental disorder. Davidson *et al.* (2001) found that psychosis and paranoia are adverse effects of chronic Methamphetamine abuse that can last for years even after ceasing the drug abuse habit (Davidson *et al.*, 2001). Pharmacological and physiological adverse effects have been implicated in permanent changes to neurological processes, and result in violent behavior, high risk sexual activities (Marshall & Werb, 2010) and a detrimental effects on oral health (Goodchild & Donaldson, 2007).



6.12 Conclusion

Oral health care is required for the majority of clients at substance addiction treatment centres but due to financial constraints, many are not able to receive proper care. Methamphetamine abuse results in multiple physical, mental and oral health problems. Users are partly responsible for their oral health problems associated by substance addiction because of neglected self-care (Affinnih, 1999) and postponement of treatment until they experience severe symptoms and when the disease has reached an advanced stage (Robinson *et al.*, 2005; Santolaria-Fernandez, 1995).

Users often present with poor oral hygiene, severe adverse effects on hard and soft oral structures and consequent pathological changes. Inadequate tooth brushing, hyposalivation, bruxism, a poor diet and an increased consumption of sugar-containing beverages are the main contributing risk factors.

People with a history of methamphetamine addiction are complex to manage when they attend for dental care due to the severe dental destruction. The duration of exposure to methamphetamine is related to the number of teeth that are decayed, missing and filled. Brushing frequency is often low among patients with

methamphetamine addiction. The addictive nature of methamphetamine and a lack of support for the user could prolong recovery and rehabilitation.



CHAPTER 7: RECOMMENDATIONS

7.1 General recommendations for staff at specialized substance abuse treatment centres

Oral health rehabilitation is not included as a part of rehabilitation programmes for recovering drug addicts. In view of the fact that the oral health impacts are great, the introduction of oral health initiatives should form part of the general drug addiction rehabilitation programmes.

Prevention of tooth decay should include:

1. Oral health education and instructions given by staff and visiting oral health professionals
2. Salivary substitutes which are available at pharmacies
3. Chewing sugarless gum
4. Increase intake of water (8 to 10 glasses of water a day)
5. Increasing fluoride supplementation by administering a neutral fluoride
6. Encourage the patient to reduce intake of sugary and carbonated drinks
7. Avoid consumption of caffeine, tobacco and alcoholic beverages because of their diuretic effects
8. Refer to dentist if patient presents with oral health problems
9. Brushing teeth twice a day with fluoridated tooth paste

7.2 Dental management

Dental patients who disclose illicit drug use should be referred to a physician or substance abuse rehabilitation centre for further investigation. Dentists need to be aware of the clinical presentation and medical risks presented by patients who are using methamphetamine (Hamamoto & Rodus, 2009).

Oral health professionals can play a crucial role in the early detection of methamphetamine abuse. An unusual caries appearance which reflects “Meth Mouth” should alert the clinician to investigate whether the patient are involve in any illicit

drug use. Furthermore, dentists may be the front-line healthcare workers recognizing the oral signs and symptoms of methamphetamine abuse. Therefore they need to be aware of the clinical presentation and medical risks presented by patients who are methamphetamine users.

Dentists should be aware that all patients need to be handled sensitively and effectively. Important management issues include a good history taking of the medical problems, dental problems and behavioural problems.

Establishing a good pre-treatment rapport with the patient will assist the dentist in reducing the need for postoperative analgesics, and will encourage this group of patients to return and obtain needed dental care. Restoring the dental appearance of patients recovering from methamphetamine may help them regain self-esteem.

Initial dental management should include:

1. Recognition of classical features & symptoms, encourage to stop the habit
2. Address pain and infection
3. Oral health education and instructions
4. Refer patient to physician or substance abuse rehabilitation centre
5. Diet analysis
6. Professional fluoride application
7. Restore and maintain oral health

More attention should be given to dental caries prevention to support users during recovery and to educate those who might be at danger. Collaboration between oral health care providers and substance abuse treatment centres is required to address the problem of substance abuse.

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Appendix 1: Questionnaire for methamphetamine study	Record no.	Date	Venue	In/Out Pt

Demographic Information

1. Patient's initials				
2. The first letter of the patient's surname				
3. Birthdate (Age)	Year	Month	Day	Age
4. Place of birth				
5. Are you currently married?	Yes		No	
6. Gender	Male		Female	
7.				
a. Do you have any children?	Yes		No	
b. If yes, how many children do you have? If yes and female, Did you become pregnant before 20?			No	
8. before 20?	Yes		No	
9. In which neighbourhood do you stay?				
10. Are you currently employed?	Yes		No	
11. What kind of work do you do? If no, how long have you been unemployed?				
12. a.Years				
b.Months				

Drug history

13. At what age did you start using "tik"?					
14. How long ago did you use tik (days)?					
a. Duration of addiction (years)?					
15. How often did/do you use "tik"?	Everyday				
	Weekly				
	Monthly				
	Yearly				
	Other				
16. a. How did you use tik?	Inject	Snort	Drink	Smoke	Other
b. What is the cost of a daily "dose" of 'tik' to:					

17. Please indicate the amount (grams) of tik that you mostly use to buy per day.	0 - 1g		1.1 - 2g		2.1 - 3g
	3.1 - 4g		4.1 - 5g		> 5g

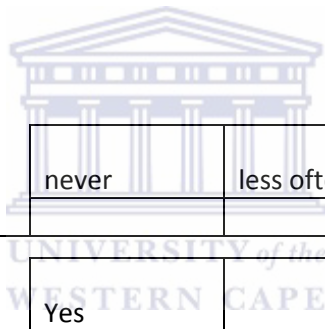
18. Did you use the above-mentioned amount all by yourself?	Yes			No	
a. How long did it take to finish?	< 24 hours	1 -7 days	2 - 4 weeks	2 - 6 months	Longer
b. If no, how many people did you share the tik with?	1 person	2 - 5 people	> 5 people		
19. Have you ever gone to a drug rehabilitation centre?	Yes			No	
a. If yes , how many times were you admitted?	Once	Twice	More		
b. Are you smoking tobacco (cigarettes)	Yes			No	
If yes, how many per day?					

Diet history

20. Describe what you mostly drink when you use tik: (e.g., Water, Soft Drinks, Beers, Brandy, Wine, Juice or something else, please explain					
21. What was the reason/s for having these drinks?					
22. How many of these drinks would you have? Per day					
(a) Per week					
23. Describe what you were eating when you used 'tik':					
24. What was the reason/s for eating these foods?					
25. How was your appetite (eating and drinking) when you were using 'tik'?	very good				
	good				
	normal				
	poor				
	very poor				

26. Where did you first hear of 'tik'?	Family	
	Friends	
	TV	
	Newspaper	
	Radio	
	School	
	University	
	Other	
27. What were your reasons to start using "tik"? Stress, boredom, to lose weight		

Dental history



28. How often do you brush your teeth?	never	less often	once a day	twice a day	more often
29. Do you think that drugs e.g. Tik can damage your teeth?	Yes			No	
a. If yes, how will it damage your teeth?					
30. When was your last dental visit?	Last 6months	1 year ago	> 1 year ago	never	
a. Why did you go to the dentist?					
b. Was any treatment done?	Yes		No		
31. If yes, what was the treatment that was done?					
32. Are you satisfied with the appearance of your teeth?	Yes			No	
a. If no, why not?					
3. Are you satisfied with the functioning (chewing ability) of your teeth?	Yes			No	
a. If no, why not?					

When you are using tik..... 34 - 41 b

34.	Do you experience that you grind your teeth?	Yes		No	
35.	Do you experience any tightening or stiffness in your facial muscles?	Yes		No	
36.	Do you ever experience a bad taste in your mouth?	Yes		No	

37.	How often do you brush your teeth?	never	less often	once a day	twice a day	more often

38.	Do you experience dental pain?	Yes		No	
39.	Do you experience sore gums?	Yes		No	
40.	Do you experience a burning sensation in your mouth?	Yes		No	

41.	Do you experience a dry mouth?	Yes		No	
a.	If yes, how long (time) after you start using tik, does your mouth become dry, please be specific	≤ 5 minutes	$> 5 \leq 60$ min	$> 1h \leq 6$ h's	> 6 hours

b.	If yes, how long (time) after you stopped using tik, does your mouth go back to normal (not dry) again (please be specific)	$> 0 \leq 60$ min	$> 1 \leq 24$ h's	$> 1 \leq 7$ days	> 7 days
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42.	Have your teeth changed in any way since you started using tik?	Yes		No	
a.	If yes, in which way did your teeth change? Please explain				

43.	Please indicate highest level of education reached:	No school			
		Primary school			
		High school			
		Tertiary (College, University)			

Medical history

46.	Do you suffer from any medical conditions?	Yes		No	
a.	If yes, what are they?				

47.	Are you taking any medication?	Yes		No	
(a)	If yes, what medication are you taking?				

Appendix 3: Calibration of dental status measurement

Pt No.	Gold Sound + Exam Sound (a)	Gold Sound + Exam Carious (b)	Gold carious + Exam Sound (c)	Gold Carious + Exam Carious (d)	Total
Pt 1	7	0	0	3	10
Pt 2	12	2	0	2	16
Pt 3	13	1	1	4	19
Pt 4	27	0	0	1	28
Pt 5	22	2	0	1	25
Pt 6	20	1	0	7	28
Pt 7	22	2	0	1	25
Pt 8	14	0	0	2	16
Pt 9	13	0	0	2	15
Pt 10	11	1	1	7	20
Pt 11	5	0	0	4	9
Pt 12	23	0	0	5	28
Pt 13	16	0	0	10	26
Total	205	9	2	49	

FREQUENCIES

		Gold Standard		
		Sound	Carious	Total
Researcher	Sound	205	2	207
	Carious	9	49	58
	Total	214	51	265

PROPORTIONS

		Gold Standard		
		Sound	Carious	Total
Researcher	Sound	0.77	0.01	0.78
	Carious	0.03	0.18	0.22
	Total	0.81	0.19	1.00

Observed	0.9585
Expected	0.6729
Kappa	0.8731

Kappa	Agreement
>0.8	Good
0.6 - 0.8	Substantial
0.4 - 0.6	Moderate

Agreement between Gold Standard and Researcher is Good

Appendix 4: Letter to treatment centre managers

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Faculty of Dentistry & WHO Oral Health Collaborating Centre
University of the Western Cape



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23 October 2011

To whom it may concern

This is a letter to elicit your support in a cross-sectional study that will be conducted to investigate the effects of Methamphetamine abuse on the mouth.

The oral clinical picture of TIK abuse is termed “meth mouth” and can be explained by contributing factors such as dry mouth, a poor appetite and ability of acidic vapour of the drug to demineralise enamel. Dentists and other health care workers are in the front-line regarding the diagnosis and recognition of the oral signs and symptoms of someone who is addicted to Methamphetamine. Primary detection can contribute to early intervention and prevention of further use.

A cross sectional study will be conducted at the Tygerberg Oral Health Centre and various Substance Addiction Centres in Cape Town. A structured questionnaire will be administered to elicit demographical details, drug use, diet, dental history, and employment status, level of education and awareness of the oral health risks associated with drug use. Clients who used Methamphetamine as a primary drug of choice will be randomly selected to participate.

Participation will be on voluntary basis and their identity will remain anonymous at all times. A signed informed consent form will be obtained from all participants and they will have the right to withdraw from the study at any stage and this will not prejudice the patient in any future treatments.

The clinical part of study will include an oral examination where their oral and dental status will be measured. This examination will be non-invasive and will be an ideal opportunity to detect dental problems that require further management.

The research proposal was given ethical clearance by the Faculty and Senate Research Ethics Committee of the University of the Western Cape.

I would like to request a formal meeting with you to discuss your prospective participation in the study.

Thanking you in anticipation

Yours sincerely

Dr Dirk A. Smit

Registrar: Dental Public Health

Department of Community Dentistry

Faculty of Dentistry & WHO Oral Health Collaborating Centre



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Appendix 5: Informed Consent form

Date:

Dear

I am a dentist and post graduate student from the Department of Community Oral Health at the University of the Western Cape. Regular use of Methamphetamine and other drugs can cause problems with the mouth and teeth and you are probably unaware of the risks associated with this habit. We are interested in interviewing you on regarding any drug habits that you may have to see if there are ways in which we can prevent any mouth problems from developing or help with any mouth problems you may have.

The interview will take about 5 - 10 minutes. There are no risks in participating. We may take photographs, but only of your teeth and no-one will be able to see your face on the photographs. All information gathered in the study will be treated as strictly confidential. No one will have access to this information except the researcher. Neither your name nor anything that identifies you will be used in any reports of this study. All information collected will be maintained and stored in such a way so as to keep it as confidential as possible. Your participation is voluntary and you may withdraw from the study at any time without any penalties.

If you would like to take part in the study, please sign the bottom of this letter. If you would like to know anything more about the study, please contact Dr Dirk Smit on telephone number at work 021-937 3147.

Thanking you in advance for your co-operation.

Dr Dirk Smit

.....

I understand what will be required of me to take part in the study. I agree to participate in the research being undertaken by Dr Dirk Smit. I understand that at any time I may withdraw from this study without giving a reason and without affecting my treatment in the future.

Name:.....
(print in block letters) (Signature)

Telephone Number:
(Witness)

Date:

Appendix 6: Patient informed consent for photography

UNIVERSITY OF THE WESTERN CAPE



FACULTY OF DENTISTRY



Patient Consent to Clinical Photography and Video Recordings	Surname:
	Name:
	Date of Birth: Gender:

I, consent to photographs or video recordings being taken of me/my child as requested, I understand that these photographs and recordings will be stored appropriately, treated with the utmost confidentiality and be part of my dental record. I hereby give consent for the images or recordings to be used ONLY for the boxes I have indicated with a tick (✓):

Record purposes and for my/my child’s future management

The photographic images and recordings will form part of the information collected for you or your child’s care and treatment. This information is handled in accordance with the HPCSA Booklet 14: Guidelines on the keeping of patient records.

Education and training purposes

The photographic images and recordings may be used for teaching purposes and viewed by health professionals outside of the UWC Faculty of Dentistry. The images may be used for example, in talks, conference presentations, posters or on the Internet to help train other health professionals in the management of dental and oral diseases

Approved research purposes & publication

This may involve the photographic images and recordings being used for example in medical or dental publications, journals, textbooks, conference material, e-publications and on the Internet. Images will be seen by health professionals and researchers who use the publications in their professional education. The images may be seen by the general public. Images will not be used with identifying information such as name, however, full confidentiality is not guaranteed.

Other purposes (please specify):

- I understand that all efforts will be made to conceal my/my child’s identity but that full confidentiality cannot be guaranteed.
- I understand that my consent or refusal will in no way affect my /my child’s dental care.

Patient Signature: **Date:**

Parent/Guardian if patient under 18 years)

Name:

Signature:..... **Date:**

Child assent (7-17 years):..... **Date:**

Witness Name & Signature:..... **Date:**