ORAL CANCER IN SOUTH AUSTRALIA

A TWENTY YEAR STUDY 1977-1996

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Dedication

This thesis is dedicated to God who gave me a mind that likes to think, to my parents, Kevin and Libby, who always encouraged me to pursue my studies, and to my beautiful wife Catherine and children Thomas, Samuel, Jacob and Sarah, who have allowed me to continue this in more recent times.

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Precis

Oral cancer comprises a group of malignancies involving the tissues of the lips and oral cavity. Oral cancer is common in humans and is consistently reported as being among the ten most frequently occurring cancers (Parkin *et al* 1993). There have been recent reports that the mortality from this form of cancer is increasing (Macfarlane *et al* 1994a; Zheng *et al* 1999; Su *et al* 1999). Globally, there is considerable geographic variation in the overall incidence of oral cancer. In most Western countries oral cancer accounts for less than 5% of all cancer cases, whereas in India it has been reported that up to 40% of al malignancies occur in the oral cavity.

The pattern of oral cancer in South Australia has not been examined in any detail for over 15 years (Roder and Wilson 1983). The purpose of this study was to carry out a review of the epidemiology of oral cancer in South Australia from 1977-1996.

Baseline epidemiological data for this study were provided by the Central Cancer Registry Unit of the Epidemiology branch of the South Australian Health Commission. This population-based cancer registry was established in 1977 and collects cancer data for the state of South Australia. Statutory cancer registration procedures enacted in 1976 mean all new cases of oral cancer are notified to the registry. Population statistics are also available from the Australian Bureau of Statistics. These data were analysed to give population-based incidence and mortality rates and trends over the 20-year period.

A total of 4054 cases of oral cancer were reported to the South Australian Cancer Registry between 1977-1996. Of these cases, 2956 (72.9%) occurred in males while 1098 (27.1%) occurred in females. The vast majority of oral malignancies were squamous cell carcinomas (88.0%) and there was an increasing incidence with age. The average age at diagnosis for oral cancer was 59.3 years in males and 66.0 years in females. The most common site of occurrence was the lip (2716 cases, 67.0%), followed by the tongue (454 cases, 11.2%), major salivary glands (302 cases, 7.4%), other and unspecified parts of the mouth (286 cases, 7.1%), floor of the mouth (226 cases, 5.6%) and the gum (70 cases, 1.7%).

Population-based incidence rates in both sexes showed that the overall "oral cancer" rates were dominated by lip cancer. There was a statistically significant increase in the incidence of lip cancer in South Australia over the 20-year period in both sexes. In males this appears to have plateaued in the past decade, although in females it continues to increase. Incidence rates for the other sites are quite low and stable in both sexes. Mortality rates for oral cancer in this state are low and stable.

The study also reviews the epidemiology of oral cancer in South Australia from a global perspective. It shows that although the incidence of cancer in the intraoral and salivary gland sites are relatively low in global terms, lip cancer incidence in South Australia is amongst the highest in the world in both sexes. The rapid and sustained increases seen in females, is an area of particular concern. This study also highlights the importance of clearly defining the term "oral cancer" and the importance of analysing trends at each individual site rather than just considering oral cancer in its totality.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying.

Simon Reading Moore
July 1999

Material derived from this study has been submitted for publication as follows.

1. Moore SR, Johnson NW, Pierce AM, Wilson DF (1999). The epidemiology of lip cancer – a review of global incidence and aetiology. *Oral Diseases (In Press).*

2. Moore SR, Johnson NW, Pierce AM, Wilson DF (1999). The epidemiology of tongue cancer – a review of global incidence. *Oral Diseases (In press).*

3. Moore SR, Johnson NW, Pierce AM, Wilson DF. The epidemiology of mouth cancer – a review of global incidence (1999). *Oral Diseases (In press).*

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Chapter One

Introduction

Oral cancer is a unique condition involving the tissues of the lips and oral cavity. It is common in humans and is consistently reported among the ten most frequently occurring malignancies (Parkin *et al* 1993). There have also been recent reports that mortality from this form of cancer is increasing (Macfarlane *et al* 1994a, Zheng *et al* 1999, Su *et al* 1999). While in Western countries it is generally recognised that the prevalence of oral cancer is greater in males and increases with age (Johnson 1991), the global pattern is far from uniform. In most Western countries oral cancer accounts for less than 5% of all cancer cases, whereas in India, 40% of cancers occur in the oral cavity. This huge geographic variation in the overall incidence of oral cancer is staggering and it is likely that a number of the site-specific racial patterns are linked to cultural habits (Smith 1979). There is also significant sub-site variation between countries, with high rates of lip cancer reported in Australia, Canada and Spain, while intraoral cancer is more frequent in India and France (Parkin *et al* 1997).

Researchers and clinicians would agree that oral cancer can usually be detected and treated early because of its accessible site, but this is not always the case. In developing countries, the majority of cases arrive at health care facilities when the disease is at an advanced stage (McMichael 1984). Late diagnosis significantly reduces survival rates and increases post-treatment morbidity. It has also been observed that survival rates from oral cancer decrease the more posterior the tumour is located in the oral cavity, giving lip cancer a much better prognosis than tumours located in the floor of mouth or base of tongue (Gerson 1990; Caplan 1993).

Sankaranarayanan *et al* (1996) summarised the widely accepted theory that oral cancer is the outcome of a multi-step carcinogenic process. This has been conceptually divided into three phases: initiation, promotion and progression. Initiation involves irreversible damage to DNA by carcinogens. Promotion is the process by which the initiated cell is converted into a pre-neoplastic or cancerous cell. Progression occurs when defects in differentiation and growth control, and increased resistance to host immunity allow uncontrolled proliferation of tumour cells. The various phases of carcinogenesis have been highlighted by molecular, cytological, pathological and clinical studies (Todd *et al* 1997). The authors propose that "pre-cancerous lesions", such as leukoplakia, submucous fibrosis and dysplasia, represent the promotion phase, while *in situ* and invasive carcinomas correspond to the progression stage. This theory also endorses the older concept of field cancerization which assumes that the whole upper aerodigestive epithelial tract is prone to the carcinogenic process due to repeated exposure to carcinogens leading to malignant transformation at various times. As a consequence, certain sites where potential carcinogens tend to accumulate or pool along with saliva, for example, the floor of the mouth and ventro-lateral surfaces of the tongue, are seen as more prone to developing oral cancer.

The pattern of oral cancer in South Australia has not been examined in any detail for the past 15 years (Roder & Wilson 1983). In this study a literature review that broadly summarises world trends in oral cancer in recent years is presented. This global picture is used as a basis for comparison with the patterns of oral cancer in South Australia over the past 20 years.

Chapter Two

Literature Review

2.1 Introduction

Epidemiology is basically a science of observation and has been defined by Lowe and Kostrewski (1973) as the "the study of the factors determining the frequency and distribution of disease in human populations". These authors list the three main aims of epidemiological studies as being:

1) to describe the size and distribution of the disease problem in human populations,
2) to provide the data essential to the planning, implementation, and evaluation of services for the prevention, control, and treatment of disease and to the setting up of priorities among those services, and
3) to identify aetiological factors in the pathogenesis of disease.

Although the literature concerning oral cancer is voluminous, there is still much that is not understood about the disease process. While the trends in occurrence in different regions may suggest different patterns of disease, it is becoming generally accepted that oral cancer involves a multi-step carcinogenic process (Speight 1993; Sankaranarayanan 1996; Todd *et al* 1997).

An important observation from the recent literature is the paucity of epidemiological studies carried out in those areas where oral cancer incidence is greatest. Oral cancer is the dominant malignancy in many areas of South East Asia, particularly India, but there is far more data on the incidence and mortality of this disease in Western countries. Apart from the well established registries in southern India, there is little reliable, population based data for most of South East Asia and the islands of Papua

New Guinea and Melanesia. There are also relatively few cancer registries in South America and almost none in the entire African continent.

The purpose of this review is to briefly examine the epidemiology of oral cancer on a global scale. This will allow meaningful comparisons to be made with the situation in South Australia over the past 20 years.

2.2 Epidemiological Studies - Methods and Definitions

Before describing the epidemiology of oral cancer, some basic terms and concepts must be defined (Binnie & Rankin 1988a; Prahbu *et al* 1992; Esteve *et al* 1994).

Prevalence is the number of cases of a disease occurring in a specific population at a given point in time.

Incidence is the number of new cases of a disease occurring in a specific population during a specified interval of time. By convention in cancer studies, *incidence* is expressed as the number of new cases per 100,000 people per year. *Incidence rates* are often presented as age-specific rates based on 5-year age groups. An *age-adjusted incidence rate* is a weighted average of the age specific rates set against a standard population usually a world standard population. This allows more meaningful comparisons between different population groups although such comparisons must always be made with some caution (Smith 1992a).

Mortality refers to the number of deaths due to a disease in a general population or community (that is not just among cases). Again, this is generally expressed as a rate per 100,000 people per year.

Survival provides a measure of the lethality of a disease. Two calculations have been suggested. The first more crude method is to compare the number of deaths with the number of annual registrations (D/R ratio) (Binnie 1976; Hindle & Nally 1991). The second more commonly used measure is the 5-year survival rate, usually given as a percentage of total number of cases, for example, a 5-year survival rate of 25% means that in a group of patients with a particular disease, only 25% will survive longer than five years from the time of diagnosis.

Cumulative rate is a newer statistic that provides an approximation of the risk of developing a disease before a particular age, in the absence of mortality (Day 1976).

Epidemiological studies can be broadly divided into three main groups:

1. Descriptive studies

Descriptive studies focus on the occurrence of a disease in a particular population and its subgroups. They outline prevalence, incidence and mortality rates and attempt to show trends in disease patterns. It is best seen as the first stage of the investigatory process allowing generation of hypotheses without aspiring to verify them (Esteve *et al* 1994). Within these studies there is scope to investigate disease patterns in terms of time trends (eg. age, period and cohort models) and geographical variations.

2. Analytical studies

Analytical studies are designed to test causal hypotheses with the aim of identifying aetiological agents in a disease process. *Case-control* or *retrospective studies* use a representative sample of cases and controls examining historical information, usually in the form of questionnaire surveys or interviews, in an attempt to discover possible aetiological agents in the disease process. *Longitudinal* or *prospective studies* begin with individuals selected according to exposure or non-exposure to the suggested causative factor. These groups are then followed prospectively and their disease incidence rates are compared. These studies result in the calculation of values such as *relative risk* (a measure of the association between exposure to a particular factor and the risk of developing the disease) and *attributable risk* (the incidence of a disease among exposed individuals due to the exposure). A major difficulty with analytical studies is separating out a single risk factor from a group of other potential factors to which the individual is exposed. This is particularly important in the case of oral cancer where tobacco and alcohol are commonly investigated and, in many cases, heavy drinkers are also heavy smokers. To draw conclusions in these studies involves a series of complicated mathematical calculations that are often difficult, if not

impossible, to verify. These problems aside, analytical studies remain the major epidemiological technique for testing causal hypotheses in a disease process.

3. Experimental studies

Experimental studies are longitudinal, prospective, follow up or cohort studies where the researcher has control over who is exposed to the suspected causal factor and when this exposure occurs. In the case of oral cancer and other potentially life-threatening diseases there are serious ethical problems with experimental studies.

An important consideration in any cancer study is the reliability of data. The establishment of cancer registries in many locations around the world has served to highlight the crucial need for accurate reporting of cancer cases and as Jensen *et al* (1990) point out, "cancer registration is the basis for any rational programme of cancer control". In some areas, including South Australia (McMichael & Bonett 1981), cancer registration is mandatory for all hospitals, haematology and pathology laboratories and these areas are usually shown to have reliable and accurate statistics. However, in other locations, such as England, cancer notification is not compulsory and data are consequently less reliable. Commenting on the likelihood of under-reporting of oral cancer in the United Kingdom, Langdon (1991) observed that "the mechanisms for recording cases are by no means watertight". This problem was subsequently confirmed in a study of oral cancer registration in south-east England, where Warnakulasuriya *et al* (1994) suggested that national incidence rates for mouth cancer may have been underestimated by about 25%. In the United States, the key source of cancer statistics is the *Surveillance, Epidemiology, and End Results* (SEER) program. The SEER team obtains cancer information from nine geographic areas across the United States covering approximately 9.3% of the total population, and this

is believed to provide a representative sample of the entire population (Percy *et al* 1995). However, in a recent study to assess under-registration of oral cancer at the Connecticut Tumor Registry during the period 1984-1988, Morse *et al* (1995) found that 2% of known oral cancer cases in Connecticut were not registered with the central body.

Access to and maintenance of accurate death notification facilities is another crucial tool in descriptive epidemiological studies and the reliability of death certificates is crucial in determining mortality rates and survival statistics. Kelson and Farebrother (1987) investigated the effect of inaccuracies in death certification and coding practices on international cancer mortality statistics. Their findings showed significant discrepancies within and between countries leading these authors to conclude that a degree of caution is needed when making epidemiological comparisons. The results of this study were supported by Percy and Muir (1989) who reported on the international comparability of cancer mortality data.

The establishment of an increasing number of population-based cancer registries allows a greater degree of standardisation and dissemination of epidemiological data. Publication of volumes such as *Cancer Incidence in Five Continents* (now in its 7th edition) serves as testimony to the recent advances in the descriptive epidemiology of cancer.

2.3 Oral Cancer

2.3.1 The Aetiology of Oral Cancer

The aetiology of oral cancer has been extensively studied over the past four decades. A watershed article in aetiology was published by Wynder *et al* (1957) and since that time there has been extensive epidemiological research aimed at identifying risk factors for and clues into the cause(s) of oral cancer. Recent research is particularly focussed on the molecular biology of oral carcinogenesis (Scully 1993a; Paterson *et al* 1996; Wong *et al* 1996; Todd *et al* 1997), with particular interest in the role of oncogenes and tumour suppressor genes in this process. Most authors would recognise that oral carcinogenesis is a multistep, multifactorial process, involving a number of possible environmental and host factors. It is not the intention of this review to focus on the aetiology of oral cancer, although a brief reference to possible causes and risk factors will be presented.

Tobacco

Tobacco habits have long been associated with oral cancer. In Western countries, this is mainly in the form of smoking, although concerns have been raised over the increasing use of chewing tobacco and snuff, particularly by younger people (Squier 1984; Depue 1986; Merne *et al* 1998). In a recent reappraisal of smokeless tobacco in the United States, Vigneswaran *et al* (1995) concluded that its use carries a lower risk of oral cancer than smoking. The World Health Organisation has concluded that there is "*sufficient evidence* that tobacco smoke is carcinogenic to humans" (WHO 1986) and the vast majority of studies and reviews return to tobacco smoking as the most significant risk factor in oral cancer (see Table 1).

Author(s)	Country/Location of study
Andre *et al* (1995)	France (Doubs region)
Blot *et al* (1990)	United States
Boyle *et al* (1988)	Review article
Bundgaard *et al* (1994)	Denmark
Cox *et al* (1995)	New Zealand
Elwood *et al* (1984)	Canada
Fahmy *et al* (1983)	Iran
Franceschi *et al* (1990b)	Northern Italy
Herity *et al* (1981)	Republic of Ireland
Hindle *et al* (1996)	Review article
Johnson and Warnakulasuriya (1993)	Review article
Jovanovic *et al* (1993b)	Netherlands
Ko *et al* (1995)	Thailand
La Vecchia *et al* (1988)	Italy
Lu *et al* (1996)	Taiwan
Lyon *et al* (1977)	Utah
Macfarlane *et al* (1995a)	United States, Italy and China
Mashberg and Samit (1989)	Review article
McCredie *et al* (1990)	New South Wales
McMichael (1984)	Review article
Moller (1989)	Denmark
Oreggia *et al* (1991)	Uruguay
Pindborg (1977)	Review article
Sankaranarayanan *et al* (1990b)	India
Smith (1989)	Review article
Smith (1977)	Review article (United States)

Table 1. A selection of recent studies and review articles that implicate tobacco smoking in the aetiology of oral cancer.

In many non-western countries, the widespread cultural practice of chewing tobacco as part of the betel quid or pan has been strongly linked to the formation of oral cancer (WHO 1985; Nandakumar 1990; Sankaranarayanan 1990a; Sankaranarayanan *et al* 1990b; Ko *et al* 1995; Lu *et al* 1996; Chen *et al* 1999). According to Sankaranarayanan (1990a) these practices are often linked to cultural beliefs about the medicinal benefits of betel leaves and other ingredients of the quid, while Wilson *et al* (1992) note that it may also be used as a religious offering or payment to priests, as

part of ceremonies involving contractual negotiations or as a sign of respect or regard. These strong cultural ties mean primary prevention through control of the habit will likely prove a difficult if not impossible task.

Reichart *et al* (1990), reporting on oral cancer in Northern Thailand, noted a fall in the incidence of oral cancer in recent decades that paralleled the disappearance of many of the traditional chewing and smoking habits. Similar observations have been made in Bombay, India, where bidi smoking and tobacco chewing have decreased (Jayant & Yeole 1987) and in Hanoi, Vietnam, where the betel chewing habit is declining (Pham *et al* 1993). These studies provide further evidence of the importance of tobacco in its various forms, as a key aetiological factor in the development of oral cancer.

Alcohol

Alcohol consumption is another factor commonly linked to oral cancer. Many of the studies examining tobacco usage (see Table 1) have also studied the effect of alcohol on the development of oral cancer. While there seems to be general agreement that alcohol is an important risk factor, it is often difficult to separate out its relative importance since many studies have shown that heavy drinkers are also heavy smokers. Some researchers (Elwood *et al* 1984; Mashberg *et al* 1989; Moller 1989; Andre *et al* 1995) found alcohol to be more significant than smoking, although most studies lean more heavily towards tobacco as the major risk factor. A number of researchers (Herity *et al* 1981; Blot *et al* 1988; Franceschi *et al* 1990b; Ko *et al* 1995) claim to have demonstrated a synergistic or multiplicative effect of alcohol and tobacco acting in combination in the development of oral cancer. Blot *et al* (1988)

proposed that smoking and alcohol account for approximately 75% of all oral and pharyngeal cancers in the United States.

There has been some suggestion in the literature (Winn *et al* 1991) that alcohol found in commercially available mouthwashes might be an additional risk factor for oral cancer. A recent review (Elmore & Horwitz 1995) examined seven published studies of this possible aetiological factor carried out between 1976-1995. These researchers concluded that "neither the data for the overall association nor the analysis in patients without other clinical risk factors support a link between mouthwash use and oral cancer".

Oral health status

Although for many years clinicians and researchers have suggested that oral cancer is related to poor oral health, there is limited epidemiological evidence to substantiate this association (Graham *et al* 1977). While it is feasible that broken teeth and/or restorations, poorly fitting dentures and other sources of chronic irritation may contribute to the development of oral cancer, the difficulties in quantifying these factors mean it will always be difficult to establish this as a definite risk factor.

Diet and nutrition

Epidemiologic studies have consistently shown that oral cancer patients have lower than average nutritional status, while regular ingestion of certain foods, especially fresh fruits and vegetables, seems to provide a protective effect. (Herity *et al* 1981; Winn *et al* 1984; McLaughlin *et al* 1988; Moller 1989; La Vecchia *et al* 1993a; Zheng *et al* 1993; Macfarlane *et al* 1995a). Brookes and Clifford (1981) linked nutritional

status with general immune competence to show how these factors were important prognostic indicators for patients diagnosed with head and neck cancer.

In recent years, research has turned to the prophylactic use of nutrients and micronutrients in the chemoprevention of cancer (Hakama *et al* 1996; Stewart *et al* 1996). Chemoprevention has been defined as "intervention in the process of carcinogenesis with dietary or chemical agents with the aim to prevent or delay the development of cancer" (de Vries *et al* 1992). The agents commonly suggested are vitamin A (retinoids) and antioxidants such as N-acetylcysteine (NAC), beta-carotene & vitamin E (Scully & Boyle 1992). Naturally occurring algae, such as *Spirulina fusiformis* that are rich in a number of micronutrients, are also being investigated (Sankaranarayanan *et al* 1996). Chemoprevention trials against cancers of the head and neck are currently underway, for example, EUROSCAN (de Vries *et al* 1994). These studies are focusing on chemoprevention of second primary tumours as opposed to the traditional management of intensified screening programs and the preliminary results appear promising. If successful, chemoprevention may become an extremely effective primary prevention strategy in developing countries where oral cancer remains a major health problem.

Socioeconomic status

While income and education have been suggested as risk factors for oral cancer (Smith 1979), there is very little data to substantiate these claims (Douglass *et al* 1984). It does seem feasible, however, that socioeconomic status may be linked to the nutritional factors discussed above, a point expanded further by Macfarlane *et al* (1996) in their discussion of increasing trends of oral cancer in Scotland. Elwood and

Gallagher (1985) have also demonstrated that patients with a higher socioeconomic status were more likely to have oral cancer diagnosed in the early stages of the disease. In this study, early diagnosis of oral cancer was also linked to regular dental care and low levels of alcohol consumption.

Familial or genetic factors

According to Boyle *et al* (1995), oral cancer does not tend to cluster strongly in family groups, but Ankathil *et al* (1996) in a recent pedigree analysis from India found some evidence of family aggregation. These authors proposed an autosomal dominant mode of inheritance for an "oral cancer susceptibility gene". Cannon-Albright *et al* (1994) demonstrated unusually high levels of familial clustering for lip cancer in Utah between 1967-1977. These authors conceded that this observation may primarily reflect environmental influences, such as an increased exposure to ultraviolet radiation, but the possibility of inherited susceptibilities could not be ruled out. Merrick *et al* (1986) also reported familial clustering of salivary gland carcinomas in Greenland, and proposed that genetic predisposition might play an important role in the development of this form of oral cancer. Gorsky *et al* (1994) also showed clear ethnic links in oral cancer incidence, while other researchers (Hamner 1986; Steele & Shillitoe 1991; de Vries *et al* 1992) firmly believe that genetic susceptibility (for example, chromosome fragility and oncogene activation) plays an important role in oral carcinogenesis. Recent molecular studies appear to confirm this theory (Wong *et al* 1996; Todd *et al* 1997). Goldstein *et al* (1994) demonstrated a slightly increased risk for developing oral cancer in individuals who had family members with oral cancer, but they concluded that this familial tendency is most likely related to environmental factors, especially smoking and drinking.

Viruses

Viruses have been implicated in the development of cancer in other squamous epithelia, most notably cervical carcinoma, so it has been postulated that they also play an important role in oral carcinogenesis. Using modern techniques of gene mapping, a number of viruses have been studied including Epstein-Barr virus (EBV), cytomegalovirus (CMV), herpes simplex virus (HSV) and human papilloma virus (HPV). Some researchers (Steele & Shillitoe 1991; Scully 1993a) are of the opinion that viruses play a significant role in the aetiology of oral carcinoma, although a recent review article examining the role of high risk human papillomaviruses in oral carcinogenesis concluded that the evidence is "mainly circumstantial" (Sugerman & Shillitoe 1997).

Radiation

Elevated exposure to ultraviolet/actinic radiation has been frequently linked with lip cancer (Wurman *et al* 1975; Lindqvist 1979; Douglass *et al* 1984; Brownson *et al* 1989; Blomqvist *et al* 1991; Pukkala *et al* 1994; Awde *et al* 1996; Schouten *et al* 1996; de Visscher & van der Waal 1998). Other forms of irradiation have been proposed as significant risk factors in the development of salivary gland tumours (Spitz *et al* 1984; Horn-Ross *et al* 1991).

Occupation

Various outdoor occupations such as farming, fishing and labouring are commonly proposed as important risk factors in the development of oral cancer, particularly of the lip. This association is usually related to elevated exposure to solar radiation

(Spitzer *et al* 1975; Lindqvist and Teppo 1978; Lindqvist 1979; Douglass and Gammon 1984; Brownson *et al* 1989; Pukkala *et al* 1994; de Visscher & van der Waal 1998). Other occupations have been suggested as important in the aetiology of oral cancer, but an extensive study over 15 years in Finland (Pukkala *et al* 1994), concluded that the role of direct occupational factors was "minimal". Huebner *et al* (1992), in a large case-control study from the United States in 1984-1985, reached the same conclusion that occupation plays only a relatively small role in the pathogenesis of oral and pharyngeal cancer.

Conclusion

The aetiology of oral cancer is complex and the exact nature and pathogenesis of the disease is far from established. Scully (1993a) and others are most likely correct when they conclude that oral carcinogenesis must be the result of an interaction between a variety of environmental factors (for example, chemical carcinogens, viruses) and host mechanisms (for example, genetic susceptibility, host defences/nutrition status). According to Smith (1979), the ultimate goal for epidemiological research into oral cancer must be the "recognition of aetiological factors, removal of their influence, and measurement of a resultant significant decline in oral cancer mortality and incidence rates".

2.3.2 The Epidemiology of Oral Cancer

In studying oral cancer, researchers have discovered that its long latency period and relatively low incidence render cause and effect relationships difficult to establish (Binnie & Rankin 1988). This is further complicated by the fact that recent discoveries continue to point to oral cancer as having a multistep, multifactorial aetiology (Scully 1993a; Sankaranarayanan *et al* 1996; Todd *et al* 1997). On the other hand, the fact that this disease has a high fatality rate and relatively high degree of diagnostic reliability allows the generation of quite accurate population data that is essential for descriptive studies.

The epidemiology of oral cancer does, however, present some important challenges to both the clinician and researcher. Unlike other areas of the body, the boundaries of the oral cavity are not easy to define. As a consequence, the exact definition of oral cancer has proved to be a difficult task. A number of authors (Smith 1979; Boyle *et al* 1990; Sankaranarayanan 1990a; Jovanovic *et al* 1993a; Moreno Lopez and Esparza Gomez 1998) have emphasised the importance of precisely defining the expression "oral cancer", while also noting the diversity in terms and definitions used in journal articles, textbooks and scientific reports. To highlight the extent of this problem, Table 2 summarises some of the different terms and definitions used when referring to "oral cancer" in recent publications. The coding system outlined in the 9th revision of the *International Classification of Diseases* (ICD-9) (WHO 1977) has been used to demonstrate the diversity of expressions and definitions used in the recent literature.

Author(s)	Term(s) Used	Definition (ICD-9)
Biorklund & Wennersberg(1994)	Oral cavity	141, 143-5
Boffetta *et al* (1994)	Oral cancer	140.3-5, 141, 143-5
Boyle *et al* (1990)	Mouth cancer	143-5
	Oral cancer	140-9
Cox *et al* (1995)	Oral cancer	140-9
Day *et al* (1994)	Oral cancer	141, 143-6, 148-9
Faye-Lund & Abdelnoor (1996)	Oral tumours	140-1, 143-5
Franceschi *et al* (1990b)	Tongue and oral cavity	140-1, 143-5
Franceschi *et al* (1992b)	Tongue and oral cavity	140-1, 143-5, 149
Gazit *et al* (1984)	Oral cancer	Not defined
Goldstein *et al* (1994)	Oral and pharyngeal cancer	141, 143-6, 148-9
Grulich *et al* (1992)	Oral cavity	141, 143-5
Hamada *et al* (1991)	Oral cancer	Not defined
Hindle & Nally (1991)	Oral cancer	140-6, 149
Hindle *et al* (1996)	Oral cancer	141, 143-6
Jensen *et al* (1990)	Buccal cavity and pharynx	140-9
Johnson & Warnakulasuriya (1993)	Oral cancer	140-1, 143-5
Ko *et al* (1995)	Oral cancer	140-1, 143-5
La Vecchia *et al* (1992)	Oral cavity and pharynx	140-9
La Vecchia *et al* (1997)	Oral cancer	140-9
Macfarlane *et al* (1992)	Mouth cancer	143-5
	Intraoral cancer	141, 143-5
Macfarlane *et al* (1995a)	Oral cancer	141, 143-5
(*Summarises three studies*)	Oral cancer	141, 143-6, 148-9
	Oral cancer	140.3-5, 141, 143-6
Macfarlane *et al* (1995b)	Oral cancer	141, 143-6, 148-9
Macfarlane *et al* (1996)	Oral cavity and pharynx	140-9
	Mouth and pharynx	141, 143-6, 148-9
Mashberg *et al* (1989)	Oral carcinoma	140.3-5, 141, 143-5, 146.2
McCartan & Crowley (1993)	Oral cancer	140-9
McCredie *et al* (1995)	Mouth and pharynx	141, 143-6, 148-9
McMichael *et al* (1989)	Buccal cavity	140-5
Moller (1989)	Tongue and oral cavity	141, 143-5
Ostman *et al* (1995)	Oral cavity	140-1, 143-6, 148-9
Parkin *et al* (1993)	Oral cavity and pharynx	140-9
Pham *et al* (1993)	Oral cavity	140-5
Pukkala *et al* (1994)	Lip, tongue and oral cavity	140, 141, 143-4
	Pharynx	145-8
Roder & Wilson (1983)	Oral cancer	140-5
Smith (1979)	Oral and pharyngeal cancer	140-9
Swerdlow *et al* (1995a)	Lip; Salivary; Other oral	140; 142; 141, 143-5
Winn *et al* (1991)	Oral and pharyngeal cancer	141, 143-6, 148-9
Zheng *et al* (1998)	Oral cancer	140-9

Table 2. Examples of the different terms and definitions used to describe "oral cancer" in the recent literature.

This summary serves to illustrate the magnitude of the nomenclature problem associated with "oral cancer" and demonstrates some instances where the same author has used a different term or definition in different papers. Unfortunately there seems to be no simple solution to this dilemma and comparison of individual studies must always be carried out with some degree of caution.

Muir and Staszewski (1990) concisely outlined the advantages and disadvantages of grouping sites in oral cancer studies. Decreasing the number of sites reduces some of the classification problems and increases the number of cases for study in the broader diagnostic categories. It also eliminates a problem commonly encountered with oral cancer, namely the determination of the primary site. Boyle *et al* (1990) also referred to this problem when they noted that categorising oral cancer into subgroups may prevent a clinician from assigning a precise location to a tumour that extends over a number of anatomic structures. Chen *et al* (1990a) also noted the difficulties that may arise in mapping large lesions. The main disadvantage with combining sites is that aggregation of cancers having different biological and epidemiological characteristics results in the loss of much information (Smith 1989; Oreggia 1991). As Muir and Staszewski (1991) pointed out, the distortion resulting from a broad grouping is especially pronounced for populations with an extremely high incidence of one of these cancers. Chen *et al* (1992) demonstrated an important example of this problem when they showed how combining lip cancer data with intraoral cancer data under the broader category of "oral cancer" can distort or mask the data relating to "intraoral cancer". Other authors (Smith 1973; Smith 1979; Smith 1989; Morse *et al* 1999) have also noted this problem.

In this review and subsequent investigation of the South Australian data, "oral cancer" is defined as lip (140 ICD-9), tongue (141 ICD-9) and mouth (143-5 ICD-9). Although salivary gland tumours (142 ICD-9) will also be included, their unique pathology and epidemiology indicates that they should probably be considered as a separate form of cancer. There is also compelling evidence in the South Australian data that lip cancer (140 ICD-9) should be considered separately from other forms of intraoral cancer (141, 143-5 ICD-9).

2.3.3 Oral Cancer - World Data

Bearing in mind the epidemiological problems of comparing statistics on oral cancer, this section attempts to synthesise the world data relating to oral cancer incidence and mortality trends. The review begins with data on oral cancer drawn from studies where all subsites are combined. This is followed by a more focused comparison of individual oral subsites, using cancer atlases or maps as a guide. The statistics for these incidence maps have been captured from *Cancer Incidence in Five Continents, Volume VII* (Parkin *et al* 1997) and figures are given as rates per 100,000 per year, age-standardised to a world population. In the text these data are supplemented by references to more specific epidemiological studies and reviews.

The majority of studies on oral cancer have found that, with the exception of salivary gland tumours, squamous cell carcinoma is the dominant histopathological type (Smith 1979; Walton *et al* 1991; Daftary *et al* 1992; Muir & Weiland 1995). Oral cancer usually occurs more frequently in males, although some researchers have noted a decrease in the male/female ratio in recent years (Gazit 1984; Devesa *et al* 1987; Chen *et al* 1991; Barasch *et al* 1995; Devesa *et al* 1995; Hindle *et al* 1996). This is explained by a fall or plateauing in the male incidence rate, combined with increasing incidence in women.

In general, oral cancer is a disease of the elderly with the average age at diagnosis in the sixth or seventh decade (Krolls and Hoffman 1976; Johnson 1991). A number of authors have highlighted increasing incidence and mortality trends for oral cancer (Macfarlane *et al* 1994a). While these increases are seen particularly in younger cohorts (Depue 1986; Davis and Severson 1987; Devesa *et al* 1987; Macfarlane *et al*

1987; Jensen *et al* 1990; Franceschi *et al* 1992a; Macfarlane *et al* 1992; Boyle *et al* 1993; Coleman *et al* 1993; Biorklund and Wennersberg 1994; Devesa *et al* 1995; Hindle *et al* 1996), this does not seem to be a uniform global pattern.

Mortality from oral cancer is site dependent with a trend of decreasing survival as the primary site moves more posteriorly in the oral cavity. This means that cancers of the lip show much better 5-year survival (80-90%), than those of the floor of mouth, base of tongue or soft palate (30-40%) (Renson 1990). Gerson (1990) referred to certain areas of the mouth where saliva tends to pool, thereby keeping the oral mucosa in contact with potential carcinogens for longer periods of time. These more susceptible intraoral areas that have been called the "gutter zone" (Johnson and Warnakulasuriya 1993) are also generally covered by a non-keratinised epithelium, theoretically making penetration by carcinogens easier.

In addition to primary site, survival rates are also closely linked to the extent of the initial lesion. While spread to regional nodes adversely affects five-year survival rates, the presence of distant metastases reduces five-year survival to 21% or less regardless of site - lip excluded (see Table 3).

Primary Site	Five-year survival (%)		
	Local	Regional nodes	Distant metastases
Oral cavity and Pharynx (140-9)	75	40	17
Lip (140)	93	82	-
Tongue (141)	65	31	11
Floor of Mouth (144)	73	44	21
Gum and other mouth (143, 145)	71	49	20
Oropharynx (146)	52	30	7

Table 3. Summary of the impact of the extent of lesion on the five-year survival rate of oral cancer (Gerson 1990).

In a study on data from the Connecticut cancer registry, one of the oldest population-based registries in the world, Chen *et al* (1990a) showed oral cancer rates in males falling from 14.5 per 100,000 per annum in the late 1930's to 4.1 per 100,000 per annum in the early 1980's. During this time they also observed a significant fall in the male/female ratio due primarily to a rise in the female incidence rate. The Connecticut trends have been confirmed in a more recent study (Morse *et al* 1999) and are duplicated elsewhere in the United States. In California, Walton *et al* (1991) reported a decrease in oral cancer, particularly lip cancer. Devesa *et al* (1987), in a broader epidemiological study of a number of areas of the United States, found rates for cancer of the mouth and pharynx were rising in females while the overall male rates remained stable. The relatively stable age-adjusted incidence rates, however, have been shown to mask differing trends by age group. While decreases occurred among older age groups, for example, those over 85, increases occurred among males aged 45-64. According to La Vecchia *et al* (1993b), mortality rates for oral and pharyngeal cancer in Canada and the United States have remained relatively stable in both males and females between 1955-1989.

There is little published data concerning oral cancer in South America although Junior *et al* (1994) presented preliminary statistics for oral carcinoma and potentially malignant lesions in Brazil. Reviewing trends in cancer mortality in the Americas between 1955-1989, La Vecchia *et al* (1993b) found a heterogenous pattern for oral and pharyngeal cancer; to improve comparability all oral and pharyngeal sites (140-149 ICD-9) were grouped together. Puerto Rico and Cuba reported high mortality rates for oral cancer (around 10 per 100,000 per annum) in the 1960's. Subsequently

rates have remained stable in Puerto Rico, fallen in Cuba, and risen in Argentina and Uruguay.

In a global review of the epidemiology of mouth cancer in 1989, Boyle *et al* (1990) found high male incidence rates in France (range 6.9-13.5) and India (range 6.5-8.0), while Northern and Eastern European countries and some Asian population groups (Japanese and Chinese), showed the lowest rates. In contrast to these findings, Lu *et al* (1996) reported a relatively high and rising incidence rate of 4.5 per 100,000 per annum for oral cancer in males in Taiwan. Boyle *et al* (1990) also reported that the incidence of oral cancer was decreasing in many areas including the United States, Australia and Czechoslovakia, while there were significant increases in some of the Nordic countries. On the other hand, these researchers found that the mortality from oral cancer was increasing in a number of regions, a fact supported by La Vecchia *et al* (1992) in their extensive review of cancer mortality in Europe from 1955-1989.

The results of Jensen *et al* (1990) supported the broad geographic trends of cancer incidence and mortality in the European Community, when they reported high rates in France, Luxembourg and Italy and low rates in Greece and the Netherlands from 1978-1982. These investigators showed that oral and pharyngeal cancer is the third most common form of cancer in French males (33.9 per 100,000 per annum) only exceeded by lung and prostate cancer, and that it has the second highest mortality rate in men (19.2 per 100,000 per annum) after cancer of the lung. Jensen *et al* (1990) did not find however, the increases in mortality reported by La Vecchia *et al* (1992).

Examining oral cancer in England and Wales between 1900-1990, Hindle *et al* (1996) observed that oral cancer mortality peaked in the 1920's and then declined until the mid-1970's. Although the overall rate has remained stable since then, more detailed analysis has revealed an upward trend in both incidence and mortality rates for younger age groups. Scotland has higher incidence and mortality rates for oral cancer than England and Wales (Johnson and Warnakulasuriya 1993), and Macfarlane *et al* (1992) found that the Scottish rates are increasing. This significant upward trend has occurred since the mid-1970's and once again this rise seems particularly pronounced among younger age groups. A similar cohort-linked increase has also been observed in Denmark (Moller 1989). In an extensive study of oral cancer in Sweden from 1960-1989, Ostman *et al* (1995) found a slight increase in incidence rates although the trends were not consistent across the various sites.

Plesko *et al* (1994) reported a steady increase in the incidence of oral and pharyngeal cancer in Slovakia in males from 1968-89. Zaridze and Basieva (1993) reported high incidence rates for cancer of the mouth and pharynx in males in 1989 in the Commonwealth of Independent States, the Baltic States and Georgia. The overall incidence rate for males in the former USSR was 15.7 per 100,000 per annum, indicating that the mouth and pharynx was the third most common cancer site after the lung and stomach. The female rate was much lower at 2.1 per 100,000 per annum. No time trends were given in this report.

Macfarlane *et al* (1994a) analysed national datasets in 24 countries to assess changes in cancer mortality from 1950-1990. These authors demonstrated a pattern of increasing cohort-linked oral cancer mortality in men that was particularly

pronounced in Central and Eastern Europe. This finding is supported in a more recent study by La Vecchia *et al* (1997), where Hungary, Germany FRG and Romania show the greatest increases in oral cancer mortality for males between 1955-1959 and 1990-1992. Zatonski *et al* (1996) also report "a dramatic increase of mortality in males" for cancer of the oral cavity and pharynx in Central Europe since the mid-1960's.

For many years, oral cancer has been recognised as a major health problem in India. The oral cavity is the most frequent site for cancer in India with Pindborg (1977) reporting that in excess of 45% of all cancers occur at this site. More recent studies from various cancer hospitals in India reveal a frequency ranging from 15-20% for oral cancer relative to all cancers, with male incidence rates ranging from 11.0 to 25.0 per 100,000 per annum (Sankaranarayanan 1990a). The high incidence rates for oral cancer in India are frequently linked to tobacco chewing habits. It is interesting to note that migrant studies reveal an increased risk for oral cancer in ethnic Indians even after they have immigrated to the United Kingdom (Swerdlow *et al* 1995b). Elsewhere in Asia reported oral cancer rates are lower, with Hanoi, Vietnam recording a male incidence rate of 2.2 per 100,000 per annum (Pham *et al* 1993). In two recent studies of oral cancer mortality trends in Japan, however, Su *et al* (1999) and Zheng *et al* (1999) have reported increasing mortality rates in males between 1950-1994 and 1950-1993 respectively. These results confirmed the findings of an earlier study (La Vecchia *et al* 1993c), although these authors had combined all sites of the oral cavity and pharynx (140-149 ICD-9) in their analysis.

In Australia the trends are not clear. Macfarlane *et al* (1994b) studied oral and pharyngeal cancer in New South Wales between 1972-1990 and found that despite an

increase in incidence rates during the mid-1970's and early 1980's, this trend has not continued. Conversely, McCredie *et al* (1995) reported an increase in both incidence and mortality rates for the same sites between 1973 and 1992. These authors proposed a number of reasons for this increase, including increased detection/earlier diagnosis, changing diagnostic practices, changing registration procedures and a changing prevalence of risk factors. La Vecchia *et al* (1993c) reported increasing mortality rates for cancer of the mouth and pharynx in Australian males from 1955-1989, particularly those aged 35-64 years. Data from South Australia (Roder & Wilson 1982) showed high oral cancer rates for males, with nearly 65% of these lesions being lip cancer. The earliest reported studies on oral cancer in Australia are a series of articles by Tan (1969; 1970a; 1970b). However, these are based on medical case histories and provide little comparable population-based data.

According to a recent study by Cox *et al* (1995), oral cancer in New Zealand is becoming a more serious problem. These authors found a significant increase in the incidence rates for all subsites of oral cancer in both males and females and reported that mortality has also increased in New Zealand between 1955-1991. La Vecchia *et al* (1993c) also reported increases in mortality rates for cancer of the mouth and pharynx in New Zealand males between 1955-1989. As with the Australian data, these increases were particularly pronounced in the cohort aged 35-64.

2.3.3.1 Lip Cancer 140 (ICD-9)

Lip cancer is a unique form of oral cancer occurring at the junction between the oral cavity and the skin. As a consequence, the reliability of data concerning lip cancer is often confused by difficulties determining the precise site of origin. The majority of these lesions arise on the vermilion border ("lipstick zone"), that is, the area between the labial mucosa and the dermis of the lip. While most of these cancers are recorded as oral cancer, there is the potential that some will be classified as skin cancer. Macfarlane *et al* (1993) referred to this potential classification problem noting that in the case of large lesions it may be impossible to determine the exact site of origin of the tumour. To eliminate this risk in South Australia, lip cancer figures include the skin of lip subsite (173.0 ICD-9). It should be noted, however, that this practice has the potential to elevate the South Australian figures. Morton *et al* (1983) observed the "ambiguity and non-uniformity" in the literature regarding lip cancer and referred back to a definition by Ebenius from 1943: "No other cancer than that arising in the red of the lip should be regarded as genuine lip cancer".

Regardless of the difficulties defining the primary site of lip cancer, the general trends reveal that it occurs more often in men, has a peak occurrence in the sixth and seventh decades, and is more common on the lower lip than the upper lip (Fahmy *et al* 1983; Chen *et al* 1992; Daftary *et al* 1992; Antoniades *et al* 1995; Ostman *et al* 1995; Faye-Lund & Abdelnoor 1996; de Visscher *et al* 1998; Morse *et al* 1999). It is frequently seen in men employed in outdoor activities, for example, farming, fishing and labouring. Although these observations have led to the suggestion that sunlight is a key factor in the pathogenesis of lip cancer (Spitzer *et al* 1975; Lindqvist & Teppo 1978; Lindqvist 1979; Douglass & Gammon 1984; Smith 1989; Pukkala *et al* 1994;

Antoniades *et al* 1995; de Visscher & van der Waal 1998), not all researchers agree (Szpak *et al* 1977).

According to Daftary *et al* (1992), the common initial signs and symptoms of lip cancer are ulceration, encrustation and soreness. These features have led some researchers (Blomqvist *et al* 1991) to suggest that recurrent viral infection may also play a role in its pathogenesis, but no definite link has been established.

Advanced lip cancers present as extensive ulcerative and/or infiltrative lesions, but the overall growth rate is relatively slow. Lymph node metastasis is rare and, because of the accessible site of these lesions, wide excision is usually curative giving well differentiated lip cancers an excellent five-year survival rate of 80-90% (Gerson 1990; Renson 1990; Antoniades *et al* 1995; Muir & Weiland 1995). Johnson and Warnakulasuriya (1993) reported a five-year survival rate approaching 95%, for lip cancer in the United Kingdom.

While the lip is the most common site for oral cancer in many while male populations, the disease is relatively rare in black males (Lindqvist 1979; Binnie & Rankin 1988b; Parkin *et al* 1992; Parkin *et al* 1997). This trend is reversed when other intraoral sites are studied (See Table 4) and has been explained by the protective effects of skin pigments against the carcinogenic action of solar radiation (Douglass & Gammon 1984).

The global trends for lip cancer incidence males are summarised in the attached maps (Figures 1-5). As previously mentioned, lip cancer is generally more common in

males than females. It should be pointed out, however, that a number of researchers have reported a decrease in the male to female ratio for lip cancer in recent years (Chen *et al* 1992; Cox *et al* 1995; Ostman *et al* 1995). This trend has been explained in part by a fall in the male incidence rate, but in some cases it is also due to a concurrent rise in the female rates.

North America

a. Male

Available data (Figure 1a) show comparatively high rates of lip cancer in males for most of Canada, peaking with Newfoundland at 12.7 per 100,000 per annum. While this is one of the highest rates in the world, it is considerably less than the rates reported for this region and other areas of Canada in the late 1960's and 1970's. Between 1963-1966, the reported rate of lip cancer for males in Newfoundland was 28.6 per 100,000 per annum (Doll *et al* 1970), while from 1969-1972 it was only marginally lower at 27.1 per 100,000 per annum (Waterhouse *et al* 1976). Elevated rates were also reported elsewhere in Canada at this time, for example Saskatchewan 21.6 per 100,000 per annum and New Brunswick 18.3 per 100,000 per annum (Doll *et al* 1970). More recent studies have confirmed the decreasing trend in both incidence and mortality for lip cancer in all regions of Canada (Coleman *et al* 1993).

The United States shows a variable pattern of lip cancer incidence with white male rates ranging from 0.4 per 100,000 per annum in Connecticut up to 4.4 per 100,000 per annum in New Mexico. The SEER figure is 1.9 per 100,000 per annum. More detailed studies from Connecticut (Chen *et al* 1992; Morse *et al* 1999) and California (Walton *et al* 1991) confirm that, as in Canada, overall incidence and mortality rates

for lip cancer in the United States are falling (Devesa *et al* 1987; Coleman *et al* 1993; Devesa *et al* 1995). Data in the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997) support these observations, with all areas except Iowa reporting lower rates of lip cancer, when compared with the previously published data (Parkin *et al* 1992).

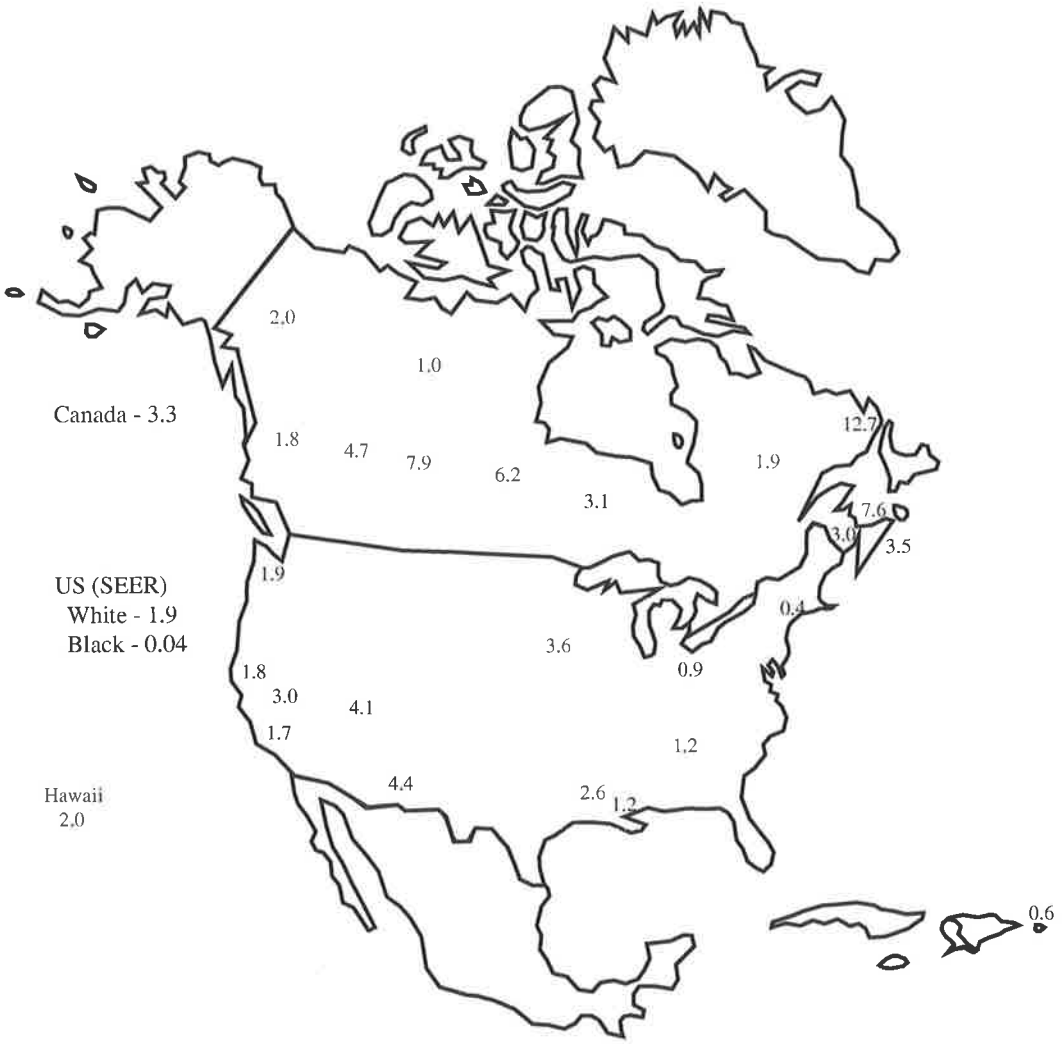

Figure 1a. North America. Incidence of lip cancer (140 ICD-9) in white males for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Of all the SEER regions, Utah has shown a consistently higher incidence rate for lip cancer over the past two decades: reported rates for males were 12.3 per 100,000 per annum between 1966-1970 (Waterhouse *et al* 1976); 10.3 per 100,000 per annum from 1973-1977 (Waterhouse *et al* 1982); 8.1 per 100,000 per annum between 1978-1982 (Muir *et al* 1987) and 10.3 per 100,000 per annum from 1983-1987 (Parkin *et al* 1992). The latest reported incidence rate for lip cancer in Utah (4.1 per 100,000 per annum), while lower than that of previous decades, is still one of the highest in the United States. These elevated rates are in sharp contrast to the low rates of oral cancer reported at other intraoral sites in Utah. The lower incidence of intraoral cancer in Utah has been explained by the "unique religious and cultural background of its residents" expressed by, for example, reduced tobacco and alcohol consumption. On the other hand, the elevated rates of lip cancer have been attributed to the high proportion of people engaged in outdoor occupations (Lyon *et al* 1975).

b. Female

The incidence of lip cancer in females in North America (Figure 1b) is much lower than the male rates in corresponding populations with only one region reporting a rate greater than 1.0 per 100,000 per annum. In Yukon, this relatively high rate (1.6) is based on a small number of cases with a high standard error. In a study of lip cancer in Connecticut over a 50-year period, Chen *et al* (1992) noted a fall in the male to female ratio from 1935-1985. These authors found that this was primarily due to a significant five-fold decrease in the male incidence rate rather than an increase in lip cancer in females.

Figure 1b. North America. Incidence of lip cancer (140 ICD-9) in white females for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

South America

a. Male

The data for lip cancer in South American males (Figure 2a) is limited, but overall the incidence appears low with only one registry, Goiania in Central Brazil, reporting a rate greater than 2.0 per 100,000 per annum. Whether this reflects the real incidence or is a function of under-reporting is not known, although the Goiania rate of 2.2 per 100,000 per annum is considerably higher than the 0.1 per 100,000 per annum reported for the same region between 1988-9 (Parkin *et al* 1992).

Figure 2a. South America. Incidence of lip cancer (140 ICD-9) in white males for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

b. Female

The reported incidence of lip cancer in females in South America (Figure 2b) is low with no registry reporting an incidence rate greater than 0.5 per 100,000 per annum.

Figure 2b. South America. Incidence of lip cancer (140 ICD-9) in white females for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Europe

a. Male

As with North America, European data (Figure 3a) shows a wide variation in the incidence of male lip cancer.

Figure 3a. Europe. Incidence of lip cancer (140 ICD-9) in white males for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

High figures have been reported for parts of Spain (up to 12.0), Poland (6.3), Belarus (5.8) and Southern Italy (4.6). This contrasts with the low rates in Central-Northern Italy (0.5), Eastern France (0.2) and England & Wales (0.5).

The Nordic countries report a moderate rate of lip cancer and a recent review of the Swedish data has shown that this rate has remained relatively stable (Ostman *et al* 1995). Jovanovic *et al* (1993a) reported that the situation in the Netherlands is typical of countries elsewhere in that region, a finding confirmed in a more recent study (de Visscher *et al* 1998). Levi *et al* (1993) found that the incidence of lip cancer in males in the Vaud, Switzerland was low, and decreased between 1975-1990. According to Antoniades *et al* (1995), lip cancer is the most common form of oral cancer in Northern Greece (59.4% compared to 40.5% for other intraoral sites), but no population based incidence rates were given.

In the United Kingdom, higher rates for lip cancer are consistently reported for Scotland, but in a recent analysis, Macfarlane *et al* (1993) reported that the incidence is steadily decreasing. The decline of lip cancer in the United Kingdom is supported by Worrall (1995) (England and Wales) and Crosher and Mitchell (1995) (Scotland), although both of these reports only provided prevalence data and not population-based incidence rates. A surprising finding was the high rate of lip cancer (11.6) reported in Southern Ireland between 1980-1982 (Muir *et al* 1987). The latest figure (3.1) was much lower (Parkin *et al* 1997). Although, no explanation for this discrepancy was found, McCartan and Crowley (1993) stated that "Previous reports of high rates of lip cancer in Irish men can now be regarded as probably inaccurate".

According to Coleman *et al* (1993), the incidence of lip cancer decreased everywhere in Europe except for Navarra and Zaragoza (Spain) between 1973-1987. Although the data from the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997) support this overall downward trend in Europe, increasing rates for lip cancer in Granada, Murcia, Tarragona and Basque County are evident, while incidence has fallen in both Navarra and Zaragoza. These data also show slight increases for parts of France. Coleman *et al* (1993) also pointed out that the rate of decline in Eastern European populations is slower than in other European countries. As with North America, the mortality from lip cancer is decreasing in most European countries (Hill *et al* 1991; Hindle & Nally 1991; Johnson & Warnakulasuriya 1993; Macfarlane *et al* 1993).

b. Female

The incidence of lip cancer in females in Europe (Figure 3b) is low with no regions reporting rates greater than 1.0 per 100,000 per annum. Although in parts of Spain the male:female ratio is greater than 15:1, in the United Kingdom and Nordic countries the ratio is much lower. According to Ostman *et al* (1995), this ratio has fallen in Sweden over the past three decades due to a combination of lip cancer incidence decreasing in males and increasing in females.

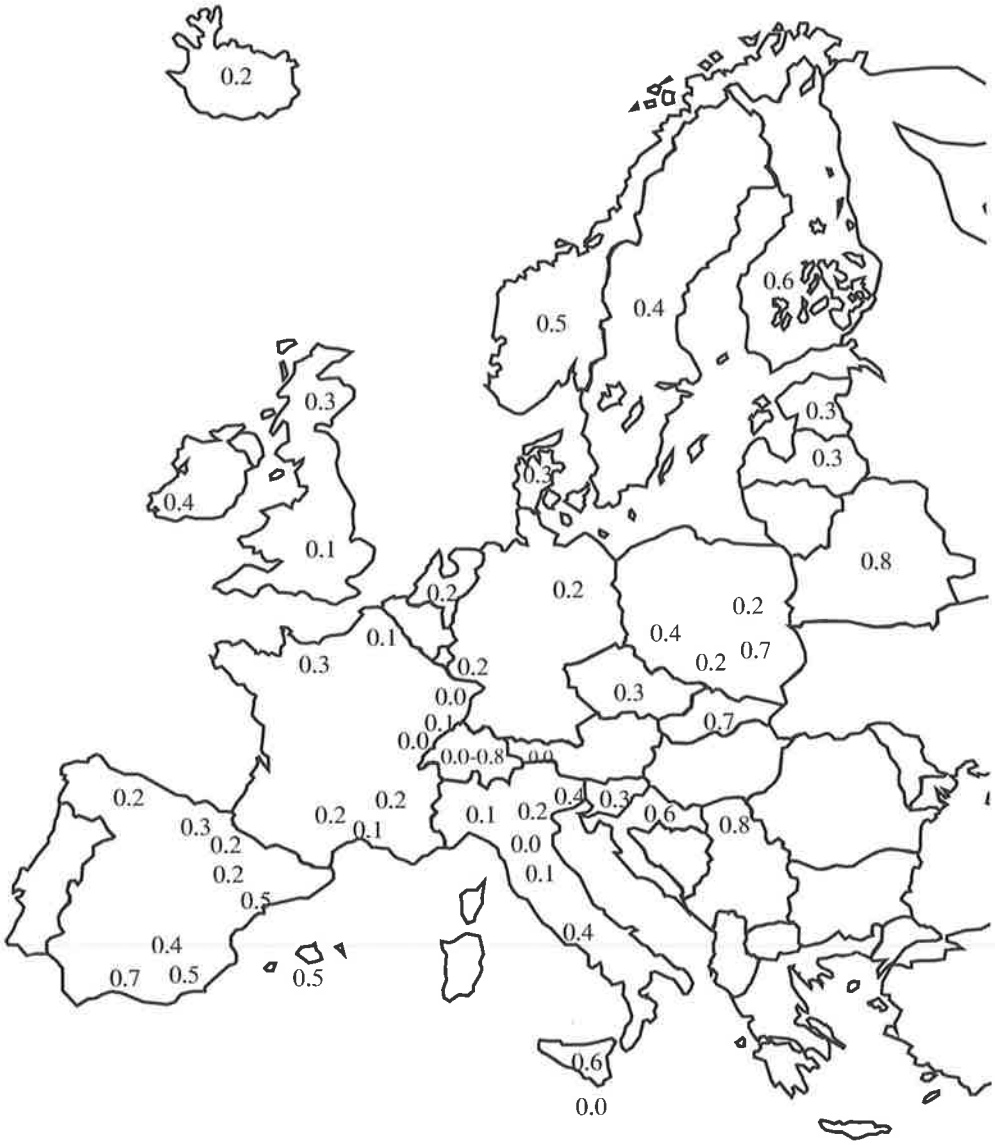

Figure 3b. Europe. Incidence of lip cancer (140 ICD-9) in white females for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).

Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Asia

a. Male

Lip cancer generally has a low reported incidence in Asian males (Figure 4a), with no regions reporting rates greater than 1.0 per 100,000 per annum. In some areas, for example, China, Japan and Singapore, lip cancer appears to be virtually unknown with rates of 0.1 per 100,000 per annum. Su *et al* (1999) and Zheng *et al* (1999) have reported decreasing mortality rates for lip cancer in Japan between 1950-1994 and 1950-1993 respectively. According to Coleman *et al* (1993), with the exception of Bombay, these low rates are showing a negative trend, indicating that the incidence of lip cancer is likely to remain low in Asia.

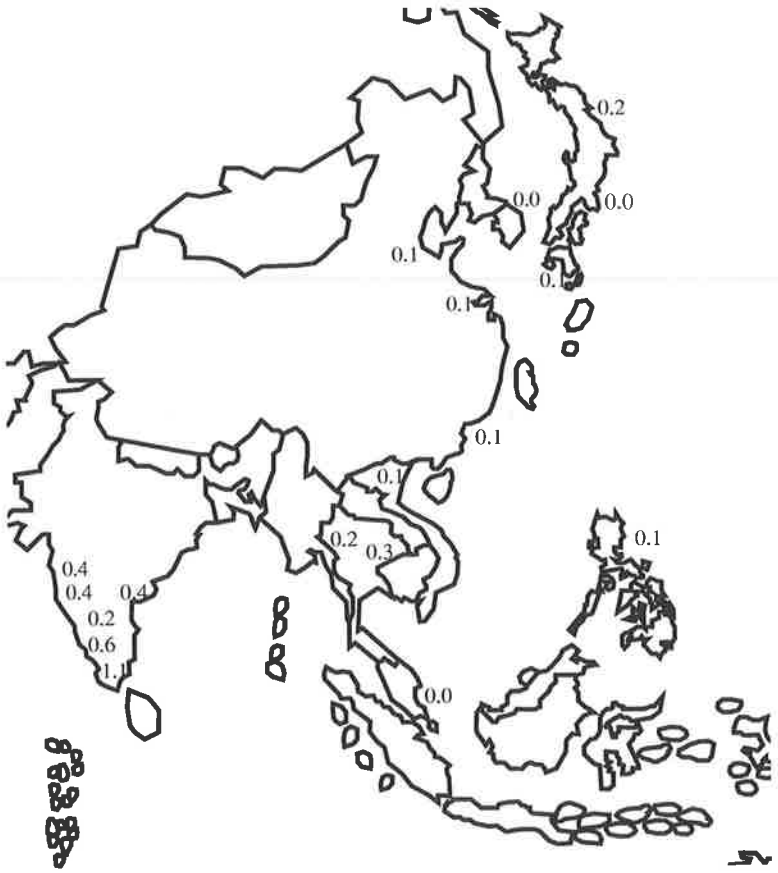

Figure 4a. Asia. Incidence of lip cancer (140 ICD-9) in males for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

b. Female

The latest data for female lip cancer in Asia (Figure 4b) shows incidence rates greater than male rates in some regions. This finding, which contrasts with the general global pattern, was seen in Thailand, Vietnam, Korea and areas of India, but no explanation for this trend was found.

Figure 4b. Asia. Incidence of lip cancer (140 ICD-9) in females for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Oceania

a. Male

Oceania (Figure 5a) has an elevated incidence of lip cancer in males with areas of Australia demonstrating amongst the highest rates in the world.

Figure 5a. Oceania. Incidence of lip cancer (140 ICD-9) in white males for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Although South Australia had the highest reported rate of 13.5 per 100,000 per annum, registries in Western Australia (8.7) and the Australian Capital Territory (8.9) also reported a high incidence of lip cancer. The incidence rate for lip cancer in the ACT from 1988-1992 was almost double the 4.5 per 100,000 per annum reported between 1978-1982 (Muir *et al* 1987). No explanation was found for this sudden

increase. The South Australian figure is considerably higher than elsewhere in Australia and, according to Coleman *et al* (1993), it has increased at a rate greater than anywhere else in the world. Unfortunately, no data were reported from the Queensland Cancer Registry between 1988-1992. In a survey of major hospitals in Australia from 1959 - 1964, Tan (1970) estimated the rate of lip cancer in Queensland to be 20.6 per 100,000 per annum, more than double the South Australian rate at that time. More recently, Muir *et al* (1987) reported the Queensland figure to be 10.8 per 100,000 per annum from 1978-1982, also greater than the South Australian figure of 9.3 per 100,000 per annum for the same period. Despite the rising trends in incidence in many regions, mortality from lip cancer in Australia decreased between 1973-1987 (Coleman *et al* 1993).

New Zealand reports a relatively low incidence rate of lip cancer among the Non-Maori male population (3.4), but a recent study by Cox *et al* (1995) found that this increased between 1955-1989. These investigators showed that, along with other oral cancer subsites, lip cancer is becoming more common in New Zealand males.

b. Female

While still lower than the corresponding rates, the incidence of lip cancer in females in Oceania (Figure 5b) is still high in global terms. South Australia again reported the highest rate of 3.2 per 100,000 per annum and more recent data confirms that the incidence of lip cancer in South Australian females continues to increase at an alarming rate (South Australian Cancer Registry 1998; 1999). Cox *et al* (1995) found a similar trend in New Zealand with the incidence of lip cancer rising faster among women than among men.

Figure 5b. Oceania. Incidence of lip cancer (140 ICD-9) in white females for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

2.3.3.2 Tongue Cancer 141 (ICD-9)

The tongue is the most common intraoral site for cancer with Chen *et al* (1990b) finding in excess of 40% of Connecticut cases occurred in this location. In Hindle and Nally's study from England and Wales (1991), over 30% of intraoral cancers were lingual, while Mashberg *et al* (1989) found a similar figure (32.6%) in a study from Torino, Italy. Using data from the Armed Forces Institute of Pathology, Krolls and Hoffman (1976) analysed 14,253 cases of squamous cell carcinoma of the oral soft tissues. They found 35.2% of intraoral lesions occurred on the tongue.

As with other oral sites, squamous cell carcinoma accounts for the vast majority (>95%) of lingual malignancies (Chen *et al* 1991; Muir & Weiland 1995; Ramirez-Amador *et al* 1995). The lateral borders and base of the tongue seem to be the most "cancer-prone" areas and, along with the floor of the mouth, make up the common intraoral sites for cancer in most populations. Researchers have suggested that this is due to the pooling of carcinogens carried in saliva in these oral food channels and reservoirs (Chen *et al* 1990b), also referred to as the "gutter zone" (Johnson & Warnakulasuriya 1993). This theory has been called Lederman's hypothesis (Mashberg *et al* 1989), and the sites most at risk are the tongue (ventral and lateral surfaces), floor of mouth, anterior tonsillar pillar and lingual aspect of the retromolar trigone.

Cancers of the anterior two-thirds of the tongue are usually detected earlier than those of the posterior one-third. Cancers of the anterior two-thirds also tend to be better differentiated, leading some researchers to suggest that tumours of the posterior one-third are more aggressive (Daftary *et al* 1991). It has also been proposed that

squamous cell carcinoma of the oral tongue in patients less than 30 years of age may be a more virulent and aggressive form of neoplasm (Byers 1975). As with other oral cancer sites, there is a definite male predilection for tongue cancer and in general, incidence rates increase with age (Chen *et al* 1990b).

The commonly cited aetiological agents in tongue cancer are once again tobacco (smoking and chewing habits) and alcohol (Oreggia *et al* 1991; Franceschi *et al* 1992b; Johnson & Warnakulasuriya 1993; Hindle *et al* 1996). Additional factors suggested are nutritional deficiencies, poor dentition and viruses (Cox *et al* 1995).

Turning to the global patterns for incidence and mortality of tongue cancer, there are significant geographic variations. These trends are summarised in Figures 6-10 and will now be discussed.

North America

a. Male

Latest data indicates that North America (Figure 6a) has a relatively low incidence of tongue cancer in males. The highest rates reported in Canada are from Prince Edward Island (3.2), Ontario (2.4) and Quebec (2.3). However Coleman *et al* (1993) found that the risk among Canadian males increased rapidly between 1973-1987.

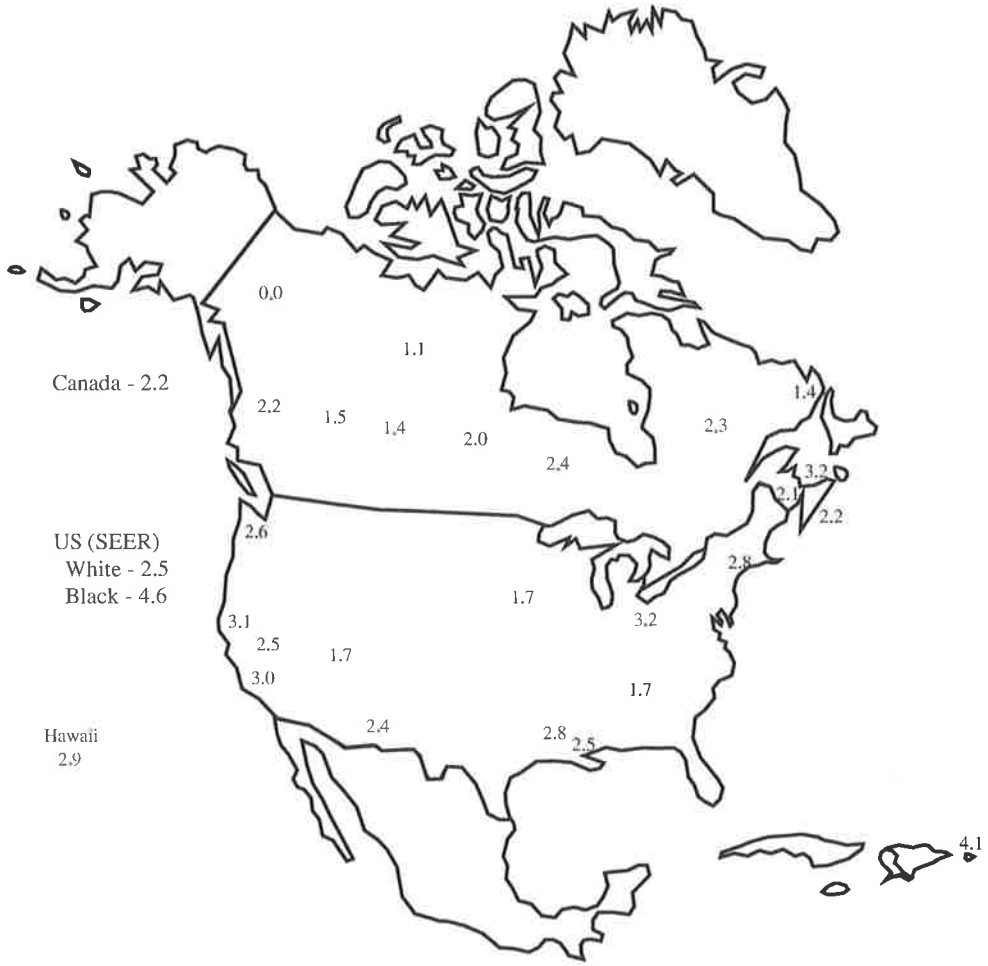

Figure 6a. North America. Incidence of tongue cancer (141 ICD-9) in white males for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

The risk of tongue cancer among white males in the United States is generally low, with only Detroit (3.2) and San Francisco (3.1) reporting rates greater than 3.0 per 100,000 per annum. Recently, however, some researchers have highlighted an increasing incidence of tongue cancer among young males in several US populations including Detroit, Seattle, and the Bay Area (Davis & Severson 1987; Coleman *et al* 1993). This has been linked to the increasing use of smokeless tobacco products such

as snuff and chewing tobacco among younger age groups (Squier 1984), though this interpretation remains controversial (Vigneswaran *et al* 1995). In another study, Depue (1986) has also shown that the mortality rate for cancer of the tongue in the United States is rising in young, white males.

Puerto Rico has consistently reported high incidence rates for tongue cancer with 9.7 per 100,000 per annum between 1964-1966 (Doll *et al* 1970), 7.5 per 100,000 per annum from 1968-1972 (Waterhouse *et al* 1976), 6.0 per 100,000 per annum between 1973-1977 (Waterhouse *et al* 1982), 5.7 per 100,000 per annum from 1978-1982 (Muir *et al* 1987) and 4.8 per 100,000 per annum between 1983-1987 (Parkin *et al* 1992). The latest incidence rate of 4.1 per 100,000 per annum between 1988-1992 (Parkin *et al* 1997) is still high although, as Coleman *et al* (1993) confirmed, the incidence of tongue cancer in Puerto Rico is declining.

A significant observation not demonstrated on the cancer maps is the markedly elevated incidence rates for tongue cancer among black male populations throughout the United States (Parkin *et al* 1997). While the US SEER figure for white males is 2.5 per 100,000 per annum, the incidence for black males is much higher at 4.6 per 100,000 per annum. This finding, also noted by Muir and Weiland (1995), is paralleled by other intraoral cancer rates, and contrasts with the incidence rates for lip cancer in white and black populations. This pattern is repeated in many areas of the United States (See Table 4). A dramatic example of this trend was reported from Bermuda between 1983-1987 (Parkin *et al* 1992), where a tongue cancer incidence rate of 16.3 per 100,000 per annum was given for black males compared with 3.8 per 100,000 per annum in the white male population. Subsequent data from this registry

was not released in the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997).

Location	Lip (140)		Tongue (141)		Mouth (143-5)	
	White	Black	White	Black	White	Black
US - SEER	1.9	0.04	2.5	4.6	3.0	5.4
Atlanta	1.2	0.0	1.7	4.2	3.5	4.9
Central Louisiana	2.6	0.0	2.8	4.3	1.0	1.8
Connecticut	0.4	0.0	2.8	6.0	3.4	6.8
Detroit	0.9	0.0	3.2	4.9	3.6	6.2
Los Angeles	1.7	0.0	3.0	3.9	3.0	4.4
New Orleans	1.2	0.3	2.5	2.8	3.7	5.1
San Francisco	0.5	0.2	3.1	4.4	1.7	4.4

Table 4. Comparison of incidence rates for lip, tongue and mouth cancer in white and black male populations in the United States between 1988-1992. Annual age-standardised rates per 100,000 (World Standard Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997)

b. Female

The incidence of tongue cancer among females in North America (Figure 6b) is generally low. Although a high rate of tongue cancer is reported for females in Northern Canada, this is based on a very small number of cases and has a high standard error. It contrasts with the otherwise low female incidence elsewhere in the country.

Figure 6b. North America. Incidence of tongue cancer (141 ICD-9) in white females for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

In a study from Connecticut reviewing 50 years of data on intraoral cancer, Chen *et al* (1990b) showed that the incidence of intraoral cancer in females, of which the tongue was the most common site, has risen. This increase, combined with a plateauing of the male incidence, resulted in a dramatic fall in the male to female ratio.

It is interesting to observe that the sharp discrepancy for intraoral cancer incidence between black and white male populations is not reflected in the female data. In many areas of the United States the incidence rates for white females are not greatly different to those of black females. In New Orleans, the rate of tongue cancer in white females (0.98 per 100,000 per annum) exceeds that of the black female population (0.74 per 100,000 per annum).

South America

a. Male

The rate of tongue cancer in males in South America (Figure 7a) varies considerably with the comparatively high rates reported for Brazil, Uraquay and Columbia contrasting with the lower rates from countries on the Western coast.

Figure 7a. South America. Incidence of tongue cancer (141 ICD-9) in white males for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Sao Paulo, Brazil, has shown elevated rates for tongue cancer over a number of decades with 5.7 per 100,000 per annum reported in 1969 (Waterhouse *et al* 1976), 5.4 per 100,000 per annum in 1973, and 7.4 per 100,000 per annum in 1978 (Muir *et al* 1987). More recent data from this region was not published in the later editions of *Cancer Incidence in Five Continents* (Parkin *et al* 1992, Parkin *et al* 1997). Although the rate of tongue cancer in other regions of Brazil (Goiania and Port Allegre) is high, it appears to be falling. Hamada *et al* (1991) showed that tongue cancer contributed 28.3% of all cancers of the mouth and pharynx (140-149 ICD-9) in males in Sao Paulo in 1978. This converts to 47.5% of all intraoral cancers (141, 143-145 ICD-9) for this region.

b. Female

The incidence of tongue cancer in South America (Figure 7b) is low with all registries, except Lima, Peru, reporting rates below the corresponding male rates. Belem in Northern Brazil, reported a relatively high incidence rate of 1.7 per 100,000 per annum, but this is still well below the corresponding male rate. In Cali (Columbia), Quito (Ecuador) and Lima, the male to female ratio is higher than elsewhere in South America. Hamada *et al* (1991) showed that tongue cancer contributed 14.6% of all cancers of the mouth and pharynx (140-149 ICD-9) in females in Sao Paulo in 1978.

Figure 7b. South America. Incidence of tongue cancer (141 ICD-9) in white females for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Europe

a. Male

The incidence of tongue cancer varies throughout Europe (Figure 8a) with high incidence rates reported in France (range 3.6-8.0), Slovakia (5.1) and Slovenia (3.6). High rates are also reported for parts of Switzerland (4.8), Germany (4.1) and Italy (3.8). Most of these regions have shown consistently high incidence rates over the past three decades.

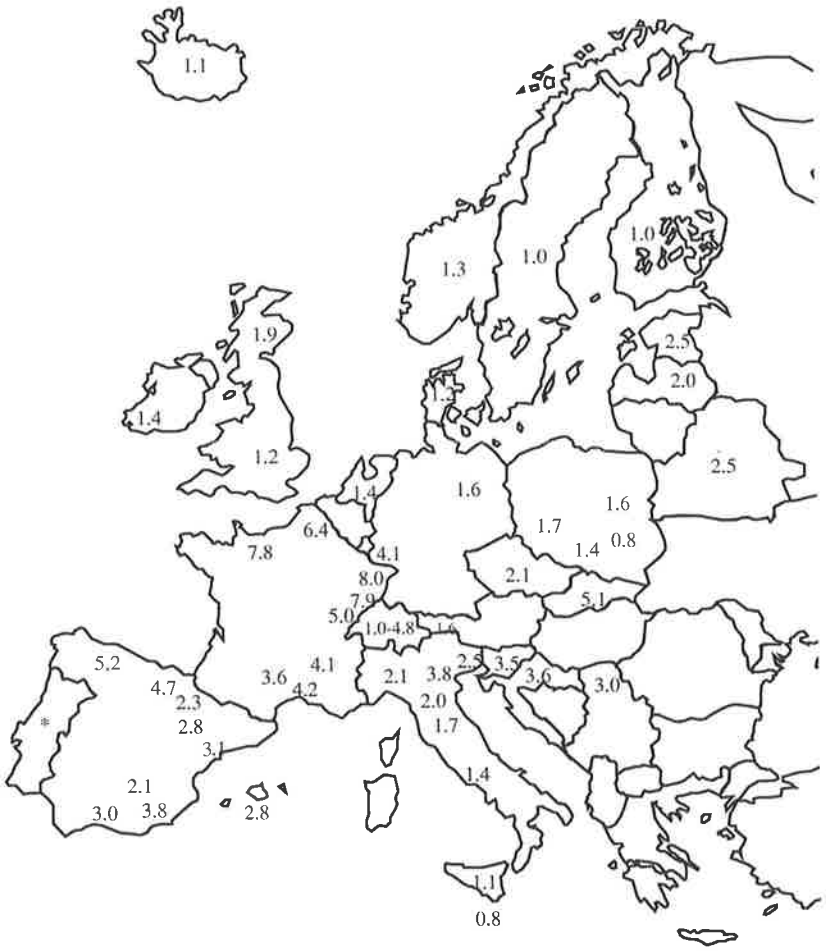

Figure 8a. Europe. Incidence of tongue cancer (141 ICD-9) in white males for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

France has the highest rates for male tongue cancer in Europe and Hill *et al* (1991) reported that mortality rates from tongue cancer in France increased 1.8 fold between 1952-1956 and 1981-1985. The observation that tongue cancer is particularly pronounced in France, a country with one of the highest alcohol consumptions in the world, has led some investigators (Andre *et al* 1995) to the conclusion that alcohol consumption is the major risk factor in these cases. A primary role for alcohol in the development of tongue cancer has also been proposed by Moller (1989), Elwood *et al* (1984) and Mashberg *et al* (1993), following studies in Denmark, Canada and the United States respectively.

Coleman *et al* (1993) highlighted the most important factor concerning tongue cancer in Europe - namely that it is increasing in most countries particularly amongst young adult males. This trend is supported by data from the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997). The fact that both incidence and mortality rates are rising significantly in males is also confirmed by separate studies from England and Wales (Hindle & Nally 1991), Scotland (Macfarlane *et al* 1992; Macfarlane *et al* 1996), France (Hill *et al* 1991), Denmark (Moller 1989), Finland (Kari *et al* 1997) and Sweden (Ostman *et al* 1995). As with recent trends in the United States, these increases seem to be cohort-linked with those born from 1915 onwards being at greater risk. Once again, the use of smokeless tobacco by young people has been suggested as a possible risk factor (Macfarlane *et al* 1987). In a detailed study of oral cancer in Scotland, Macfarlane *et al* (1996) observed that survival is lower among people from lower socioeconomic groups and the recent increases in occurrence have primarily occurred in these groups.

b. Female

According to the latest data, the incidence of tongue cancer in females in Europe (Figure 8b) is lower than that of males in all regions of Europe except Malta. An increase in tongue cancer has been reported in many European female populations including Scotland (Macfarlane *et al* 1992), England and Wales (Hindle & Nally 1991), France (Hill 1991), Sweden (Ostman *et al* 1995) and Denmark (Moller 1989). In a recent study from the two northernmost provinces of Finland (Kari *et al* 1997), the incidence of tongue cancer in females has been shown to exceed the male rate.

Figure 8b. Europe. Incidence of tongue cancer (141 ICD-9) in white females for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Asia

a. Male

For many decades, tongue cancer, along with other forms of intraoral cancer, has been a serious problem in India. The risk of tongue cancer in India is significantly higher than in other locations in Asia (Figure 9a) with most population-based registries on the Asian subcontinent reporting male rates higher than 3.5 per 100,000 per annum.

Figure 9a. Asia. Incidence of tongue cancer (141 ICD-9) in males for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Between 1983-1987, a tongue cancer rate of 14.0 per 100,000 per annum was reported for Ahmedabad in the Western Province (Parkin *et al* 1992), but more recent data from this region was not published in the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997). Bombay has shown a consistently high incidence of tongue cancer with male rates of 14.0 per 100,000 per annum between 1964-1966 (Doll *et al* 1970), 12.6 per 100,000 per annum from 1968-1972 (Waterhouse *et al* 1976), 10.2 per 100,000 per annum between 1973-1975 (Waterhouse *et al* 1982), 9.4 per 100,000 per annum from 1978-1982 (Muir *et al* 1987) and 7.4 per 100,000 per annum between 1983-1987 (Parkin *et al* 1992). The latest data shows an incidence rate of 6.5 per 100,000 per annum from 1988-1992 (Parkin *et al* 1997). Jayant and Yeole (1987) confirmed that the incidence of tongue cancer in males in Bombay fell between 1964-1982. Hamada *et al* (1991) reported that tongue cancer contributed 44.4% of all cancers of the mouth and pharynx (140-149 ICD-9) and 57.0% of all intraoral cancers (141, 143-145 ICD-9) in males in Bombay from 1978-1982.

The elevated rates in India are commonly linked to the betel chewing habits (Smith 1973; Jayant & Yeole 1987; Boyle *et al* 1989; Sankaranarayanan *et al* 1989; Daftary *et al* 1991). In this context, it is also interesting to note that although the rate of tongue cancer in Singapore is low, it is elevated among the Indian sub-population and has been for the past two decades. The extent to which this may be the result of genetic predisposition or cultural habits cannot be easily determined. Although India still reports amongst the highest rates of tongue cancer in the world, the overall risk has been described as stable or falling (Coleman *et al* 1993). Elsewhere in Asia, tongue cancer incidence rates are quite low and stable with the exception of Japan where Coleman *et al* (1993) have reported a rising, cohort-linked trend. This positive

incidence trend was not supported by recent mortality data from Japan. Zheng *et al* (1999) reported that tongue cancer mortality rates in Japanese males remained quite stable between 1950-1993, while Su *et al* (1999) found a slight fall from 1950-1994.

b. Female

The incidence of tongue cancer in Asian females (Figure 9b) is generally less than the corresponding male incidence with only Hanoi, Vietnam reporting a female incidence rate greater than the male rate. In some regions including The Philippines, Thailand and parts of India, however, the female rate is not much lower.

Figure 9b. Asia. Incidence of tongue cancer (141 ICD-9) in females for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Oceania

a. Male

The incidence of tongue cancer in males in Oceania is low (Figure 10a) with only the Western Australia registry reporting a rate in excess of 2.5 per 100,000 per annum.

Figure 10a. Oceania. Incidence of tongue cancer (141 ICD-9) in white males for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Using hospital records, not population-based data, Tan (1970a) reported a decrease in tongue cancer in Australia in the early 1960's. Limited Australian data has been published since that study. Roder and Wilson (1982) reported a male incidence rate of 1.8 per 100,000 per annum in South Australia between 1977-1980 and the same rate is reported between 1988-1992 (Parkin *et al* 1997). Coleman *et al* (1993) reported that the rate of tongue cancer in Australian males remained stable between 1973-1987

with the exception of New South Wales, where both incidence and mortality rates increased. Macfarlane *et al* (1994b) believe other factors in addition to tobacco smoking have influenced this trend, suggesting increasing alcohol and decreasing fruit and vegetable consumption may be significant. In New Zealand, Cox *et al* (1995) reported an increase in both the incidence and mortality of tongue cancer in males between 1955-1991. They also point to factors other than tobacco and alcohol as significant in this trend.

While it is generally known that intraoral cancer rates are high in other parts of Oceania, particularly Papua New Guinea (Henderson & Aiken 1979) and the islands of Melanesia (Taylor *et al* 1983), no reliable population-based data for tongue cancer incidence have been published from these regions.

b. Female

The rate of tongue cancer in females in Oceania (Figure 10b) is quite low with no regions reporting a rate in excess of 1.0 per 100,000 per annum. Roder and Wilson (1983) reported the female incidence of tongue cancer in South Australia between 1977-1980 to be 1.2 per 100,000 per annum, but the latest data shows a 50% fall to 0.6 per 100,000 per annum from 1988-1992. Cox *et al* (1995) found that the rate of tongue cancer in New Zealand females increased between 1955-1991.

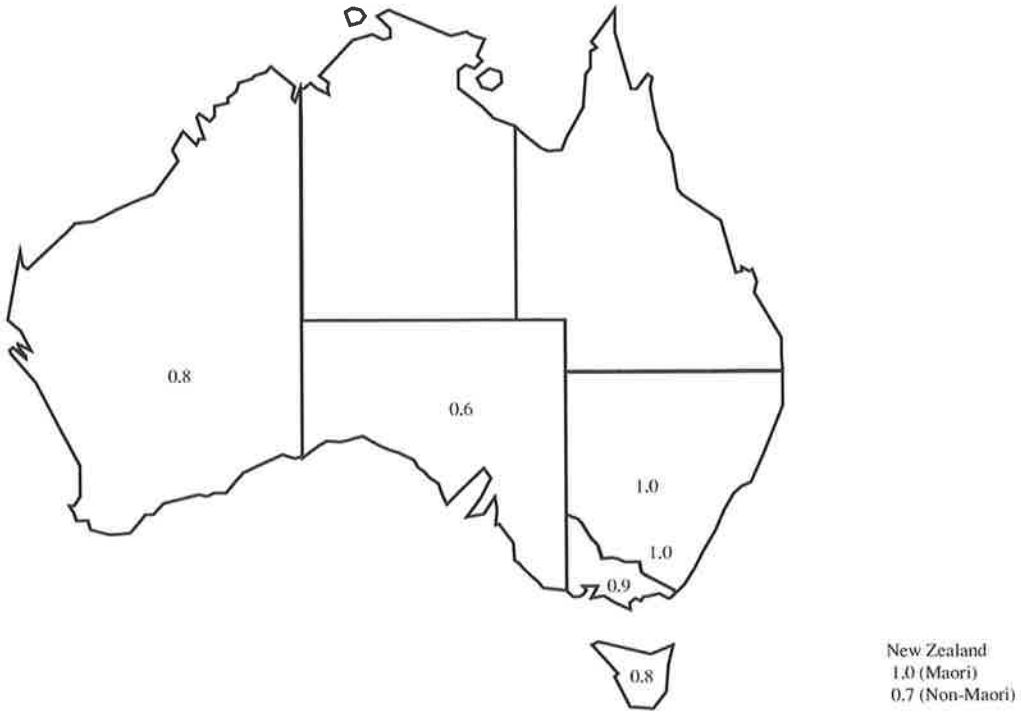

Figure 10b. Oceania. Incidence of tongue cancer (141 ICD-9) in white females for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

2.3.3.3 Mouth Cancer 143-5 (ICD-9)

Cancers of the "mouth" include lesions assigned to the gingivae and alveolar ridge, the floor of the mouth, the buccal mucosa, the hard and soft palate and the uvula and other unspecified regions of the oral cavity. Cancer in these areas has much in common with tongue cancer in terms of purported aetiology (See Lederman's hypothesis earlier), appearance, physical and clinical characteristics. Histologically, the vast majority (>95%) of lesions from these locations are squamous cell carcinomas (Chen *et al* 1990b; Daftary *et al* 1992; Muir & Weiland 1995; Ostman *et al* 1995). Not surprisingly, the global trends for mouth cancer incidence are similar to those reported for tongue cancer, although there are some variations.

North America

a. Male

The rate of mouth cancer in North American males (Figure 11a) is high in Puerto Rico, a number of areas in the United States, and regions of Canada. Nova Scotia in Eastern Canada reported an incidence rate of 3.3 per 100,000 per annum, while the Yukon registry recorded a high rate of 9.0 per 100,000 per annum. Further investigation revealed that this figure is based on a small number of cases and the standard error is quite high (Parkin *et al* 1997). According to Coleman *et al* (1993), the rate of mouth cancer was stable in most parts of Canada between 1973-1987, but increased in the Maritime Provinces. Puerto Rico has reported consistently high rates of mouth cancer for a number of decades: 6.7 per 100,000 per annum between 1964-1966 (Doll *et al* 1970), 7.8 per 100,000 per annum from 1968-1972 (Waterhouse *et al* 1976), 6.2 per 100,000 per annum between 1973-1977 (Waterhouse *et al* 1982), 6.4 per 100,000 per annum from 1978-1982 (Muir *et al* 1987) and 6.1 per 100,000 per

annum between 1983-1987 (Parkin *et al* 1992). The latest rate of 4.1 per 100,000 per annum from 1988-1992 (Parkin *et al* 1997) confirms an earlier observation that the risk of mouth cancer in Puerto Rico is falling (Coleman *et al* 1993). In the Eastern United States, New Orleans (3.7), Detroit (3.6) and Connecticut (3.4) all report mouth cancer rates above 3.0 per 100,000 per annum, while on the West Coast, high rates are recorded in San Francisco (3.2), Los Angeles (3.0) and Central California (2.9).

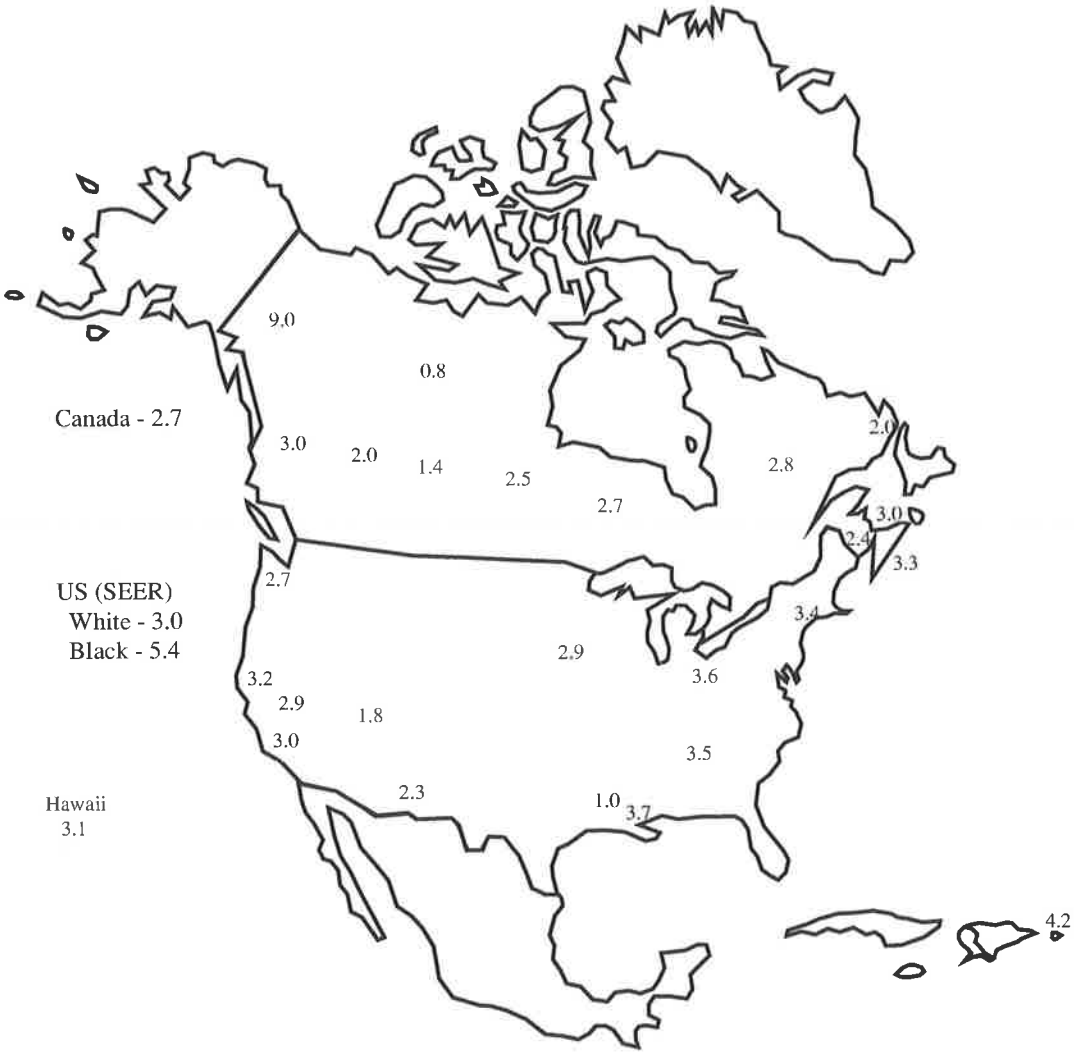

Figure 11a. North America. Incidence of mouth cancer (143-5 ICD-9) in white males for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

According to Coleman *et al* (1993), the rate of mouth cancer in Detroit increased from 1973-1987. Chen *et al* (1990) found a similar increase in Connecticut men from 1935-1985. The incidence rate for mouth cancer among white males in Hawaii has been consistently high for a number of decades. Reviewing cancer trends across the entire United States between 1975-1991, Devesa *et al* (1995) found that the incidence of cancer of the mouth (including tongue) and pharynx (combined sites) in males had fallen slightly (1.7%), while the mortality had dropped by over 20%.

As with tongue cancer, black male populations have a significantly greater risk of mouth cancer than white populations (See Table 4). Although the US SEER figures demonstrate this discrepancy, the most dramatic example of this trend was again seen in Bermuda between 1983-1987 where the incidence rate for black males was 12.1 per 100,000 per annum, compared with 3.7 per 100,000 per annum for the white male population (Parkin *et al* 1992). More recent data from this region was not published in the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997).

b. Female

The rate of mouth cancer among North American females (Figure 11b) is generally lower than corresponding male rates. Devesa *et al* (1995) found that the incidence of cancer of the mouth (including tongue) and pharynx in females in the United States was stable between 1975-1991. However, in a study from Connecticut, Chen *et al* (1990) have shown a dramatic decrease in the male : female ratio for intraoral cancer, due mainly to a sharp increase in the female incidence rate from 0.3 per 100,000 per annum in 1935 to 3.3 per 100,000 per annum in 1980. This changing trend in sex distribution of oral cancer is also supported by statistics from California (Walton *et al*

The difference in incidence rates for mouth cancer between black and white female populations in the United States is not as great as that seen in the male data. In Los Angeles, San Francisco and New Orleans, the incidence rates for mouth cancer in white females exceeded that of the corresponding black female population.

South America

a. Male

In contrast to the low incidence rates for mouth cancer in males in much of South America (Figure 12a), Brazil reported amongst the highest rates in the world (range 3.4 per 100,000 per annum in Goiania to 5.5 per 100,000 per annum in Belem).

Figure 12a. South America. Incidence of mouth cancer (143-5 ICD-9) in white males for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

According to Coleman *et al* (1993), the Brazilian male incidence rate for mouth cancer continued to steadily increase from 1973-1987. Hamada *et al* (1991) studied the epidemiology of oral cancer in Sao Paulo, Brazil in 1978 and found that mouth cancer (143-145 ICD-9) made up 31.3% of all cancers of the mouth and pharynx (140-149 ICD-9) and 52.5% of intraoral cancer (141, 143-145 ICD-9) in males.

b. Female

The incidence of mouth cancer in South American females (Figure 12b) is generally low, although, as with the male data, rates in parts of Brazil are quite high. Hamada *et al* (1991) found that in females in Sao Paulo in 1978, mouth cancer (143-145 ICD-9) made up 37.2% of all cancer of the mouth and pharynx (140-149 ICD-9) and 71.8% of intraoral cancers (141, 143-145 ICD-9).

Figure 12b. South America. Incidence of mouth cancer (143-5 ICD-9) in white females for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Europe

a. Male

As with other oral subsites, the incidence of mouth cancer among the various European male populations shows considerable geographic diversity (Figure 13a).

Figure 13a. Europe. Incidence of mouth cancer (143-5 ICD-9) in white males for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Paralleling tongue cancer, France reports the highest incidence of mouth cancer in Europe between 1988-1992 with rates ranging from 2.8 per 100,000 per annum in Tarn to 11.1 per 100,000 per annum in Bas-Rhin. Concurrently, Hill *et al* (1991) reported a steady increase in mortality rates for mouth cancer in France from 1950-1990, although Coleman *et al* (1993) suggest that this may have plateaued in the 1980's. This contrasts with a falling mortality rate from lip cancer in France over the same period (Hill *et al* 1991).

Other European countries at a higher risk for mouth cancer in males between 1988-1992 are Slovenia (5.0), Slovakia (5.4) and parts of Italy (8.4), Germany (5.3) and Spain (4.9) and the latest data seems to confirm that the incidence of mouth cancer is increasing in many regions of Europe. Geneva (Switzerland) has shown consistently elevated rates for mouth cancer over a number of years and, examining figures from the Vaud cancer registry, Franceschi *et al* (1992a) reported a decline in five-year survival rates for oral cancer (as well as pharyngeal and laryngeal sites). Although recent data was not available for Hungary, an interesting observation from earlier figures (Parkin *et al* 1992) is the relatively low reported rates for mouth cancer from 1983-1987 (range 1.9-2.2), when compared with the high incidence of tongue cancer in the same regions over the same period (range 3.7-5.7). According to Coleman *et al* (1993), however, the incidence of mouth cancer in Hungary has increased between 1973-1987.

Although the Nordic countries have a relatively low rate of mouth cancer (range 1.1-1.7) compared with the rest of Europe, Ostman *et al* (1995) have shown a significant increase in incidence in Sweden from 1960-1989. A similar increase is reported for

Denmark from 1943-1985 (Moller 1989) and this trend was confirmed by Coleman *et al* (1993), who claim that the risk of mouth cancer rose in all the Nordic countries, except Finland, between 1973-1987.

The incidence of mouth cancer in the United Kingdom is also low (range: 1.5 per 100,000 per annum in England and Wales to 2.8 per 100,000 per annum in Scotland), however, some researchers have reported increasing rates in Scotland (Macfarlane *et al* 1992; Macfarlane *et al* 1996) and Northern Ireland (Cowan *et al* 1992). Nevertheless, Johnson and Warnakulasuriya (1993) point out that the total number of cases in Northern Ireland is small. The increasing trend in Scotland is supported by the latest data from *Cancer Incidence in Five Continents* (Parkin *et al* 1997) where the incidence rate for mouth cancer rose to 2.8 per 100,000 per annum. A similar increase was noted for Southern Ireland. Coleman *et al* (1993) reported that the risk of mouth cancer in England has not changed substantially in recent years, although Hindle *et al* (1996) found significant increases in incidence and mortality for younger males between 1960-1990.

b. Female

Throughout Europe, the incidence of mouth cancer is lower in females (Figure 13b) than males. Some areas including Scotland, Iceland, Denmark and parts of France report high rates of mouth cancer in females, but these are still lower than the corresponding male populations. In Sweden, Ostman *et al* (1995) reported an increase in cancer of the floor of the mouth in females, while rates for other parts of the mouth have remained stable. Hindle and Nally (1991) showed an increase in both incidence and mortality of mouth cancer in females in England and Wales. In a more recent

study from the United Kingdom, however, Hindle *et al* (1996) found that the incidence and mortality for cancer of the oral cavity (including the tongue) had remained stable in females.

Figure 13b. Europe. Incidence of mouth cancer (143-5 ICD-9) in white females for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Asia

a. Male

The incidence of mouth cancer in males is high in many parts of Asia (Figure 14a). As with tongue cancer, India is again the focus with many regions reporting rates exceeding 6.0 per 100,000 per annum, peaking with Trivandrum registry in Southern India reporting rate of 10.8 per 100,000 per annum between 1991-1992.

Figure 14a. Asia. Incidence of mouth cancer (143-5 ICD-9) in males for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

In a study from Bombay from 1978-1982, Hamada *et al* (1991) found that mouth cancer made up 33.5% of all cancers of the mouth and pharynx (140-149 ICD-9) and 43.0% of all intraoral cancer in males. Paralleling tongue cancer trends, mouth cancer is common among the Indian sub-population of Singapore. Once again, tobacco and betel habits are implicated as the primary aetiological agents for the consistently high rates seen in India (Sankaranarayanan 1990a; Daftary *et al* 1991), but Sankaranarayanan *et al* (1989) suggested that other factors may be involved in the development of oral cancer in patients under 30 years of age. Both Jayant and Yeole (1987) and Coleman *et al* (1993) have reported a plateauing in mouth cancer incidence in India from the 1960's to the mid-1980's, but rates remain amongst the highest in the world.

In contrast to India, the risk of mouth cancer in Japan is low, but the rate has risen dramatically. The incidence rate for mouth cancer in Osaga between 1970-1971 was 0.2 per 100,000 per annum (Waterhouse *et al* 1976), while from 1983-1987 it had risen to 1.6 per 100,000 per annum (Parkin *et al* 1992). Similar trends are seen elsewhere in Japan. This trend is confirmed by two recent studies into oral cancer mortality in Japanese males. Both Zheng *et al* (1999) and Su *et al* (1999) found a significant rise in mouth cancer mortality, particularly cancer of the floor of the mouth, between 1950-1993 and 1950-1994 respectively.

Higher rates of mouth cancer are also reported for Manila (3.1) and Chiang Mai (2.6), but according to Reichardt (1995), both incidence and mortality rates for oral cancer in Thailand are decreasing. Reichardt proposed that this was primarily due to a fall in the prevalence of betel chewing in the population.

b. Female

The incidence of mouth cancer in females is high in parts of Asia (Figure 14b), and in some regions exceeds the corresponding male rate. These areas included The Philippines, Thailand and parts of India (Bangalore and Madras). A more detailed subsite analysis using four digit rubrics from the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997) revealed the majority of these cases occurred at "other and unspecified sites of the mouth" (145.1, 145.6-9 ICD-9).

Figure 14b. Asia. Incidence of mouth cancer (143-5 ICD-9) in females for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Hamada *et al* (1991), in their study of oral cancer in Bombay between 1978-1982, found that mouth cancer made up 53.2% of all cancers of the mouth and pharynx (140-149 ICD-9) and 61.8% of all intraoral cancer (141, 143-145 ICD-9) in females.

Cancer primarily originating in the soft palate is uncommon, but this unusual form of mouth cancer is seen in some areas of Asia. In areas where reverse smoking is practised, it comprises between 38-48% of all oral cancer (Daftary *et al* 1991). In contrast to other forms of intraoral cancer, palatal cancer resulting from reverse smoking is more common in women. The changes to palatal mucosa caused by this practice have recently been studied in Filipino women (Ortiz *et al* 1996a; 1996b).

Oceania

a. Male

The incidence of mouth cancer in males in Oceania (Figure 15a) is relatively low in global terms. In Australia, only Western Australia (2.6) and New South Wales (2.9) report rates higher than 2.5 per 100,000 per annum, while the New Zealand rate for the Non-Maori population is 1.8 per 100,000 per annum.

Figure 15a. Oceania. Incidence of mouth cancer (143-5 ICD-9) in white males for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

The current South Australian rate of 2.5 per 100,000 per annum is slightly higher than the 1.9 per 100,000 per annum reported by Roder and Wilson (1983) between 1977-1980. Macfarlane *et al* (1994) demonstrated considerable geographic variation in

incidence rates for intraoral cancer (including tongue) within the Sydney metropolitan area between 1972-90. While the overall incidence rate for intraoral cancer in New South Wales was 5.4 per 100,000 per annum, these authors found an incidence of 16.0 per 100,000 per annum in Sydney City.

The latest rate of 3.6 per 100,000 per annum among the male Maori population people of New Zealand is considerably higher than the previously reported 1.5 per 100,000 per annum from 1983-1987 (Parkin *et al* 1992). In Australia, mouth cancer rates seem relatively stable, although Coleman *et al* (1993) reported a slight increase from 1973-1987. Cox *et al* (1995), however, reported significant upward trends for both the incidence and mortality of mouth cancer in New Zealand between 1955-1991.

While it is generally known that intraoral cancer rates are high in other parts of Oceania, particularly Papua New Guinea (Henderson & Aiken 1979; Martin *et al* 1992) and the islands of Melanesia (Taylor *et al* 1983), little reliable population-based data for mouth cancer incidence have been published for these regions. An interesting observation, however, is the exceptionally high incidence of mouth cancer reported in Pacific Polynesian islanders between 1978-1982 (Muir *et al* 1987). This incidence rate of 10.2 per 100,000 per annum does not seem to have been further investigated. The number of cases and likely accuracy of this data is uncertain and it is also noted that the report does not record a rate for tongue cancer in this population group, which may indicate that this figure combines tongue and mouth rates. The latest data (Parkin *et al* 1997) revealed elevated rates for both tongue (3.3) and mouth (4.5) cancer in French Polynesia, indicating that these forms of oral cancer remain a serious problem in this region.

b. Female

The incidence of mouth cancer in females in Oceania (Figure 15b) is low with no registries reporting rates greater than 1.5 per 100,000 per annum. All regions report female rates lower than the corresponding male rates.

Figure 15b. Oceania. Incidence of mouth cancer (143-5 ICD-9) in white females for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

2.3.3.4 Salivary Gland Cancer 142 (ICD-9)

Salivary gland tumours are a unique and variable group of lesions that have provided much confusion in both diagnosis and management over many years. In most populations they occur less frequently than other oral cancers and are most often seen in the parotid gland. The aetiology and behaviour of salivary gland tumours is completely different from other oral cancers, a point noted by many authors and an important reason for classifying these lesions separately from other oral cancers. Pindborg (1977) regrets the modification in the ninth revision of the *International Classification of Diseases*, whereby tumours occurring in minor salivary glands were removed from the category of "salivary gland tumours" (142 ICD-9) and classified according to subsite. In his opinion, this change means, "future studies on oral cancer epidemiology will suffer." While the majority of malignant salivary gland tumours fall under the broad category of adenocarcinomas, the latest WHO classification (WHO 1990; Seifert 1991) lists eighteen distinct carcinomas of salivary glands. There is, however, no uniformity in the literature as to the exact nature and behaviour of these different tumours and the precise pathologic classification of salivary gland cancer remains a continuing problem. This review focuses on the broad category of salivary gland carcinomas of the major glands (142 ICD-9), with no attempt to subdivide this complex group of tumours further.

Apart from Europe and North America, the literature contains limited data on the epidemiology of salivary gland tumours (Ostman *et al* 1997). The attached maps (Figures 16-20) summarise data from the 7th edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997).

North America

a. Male

In North America (Figure 16a) the incidence of salivary gland cancer is low with few regions reporting a rate exceeding 1.0 per 100,000 per annum.

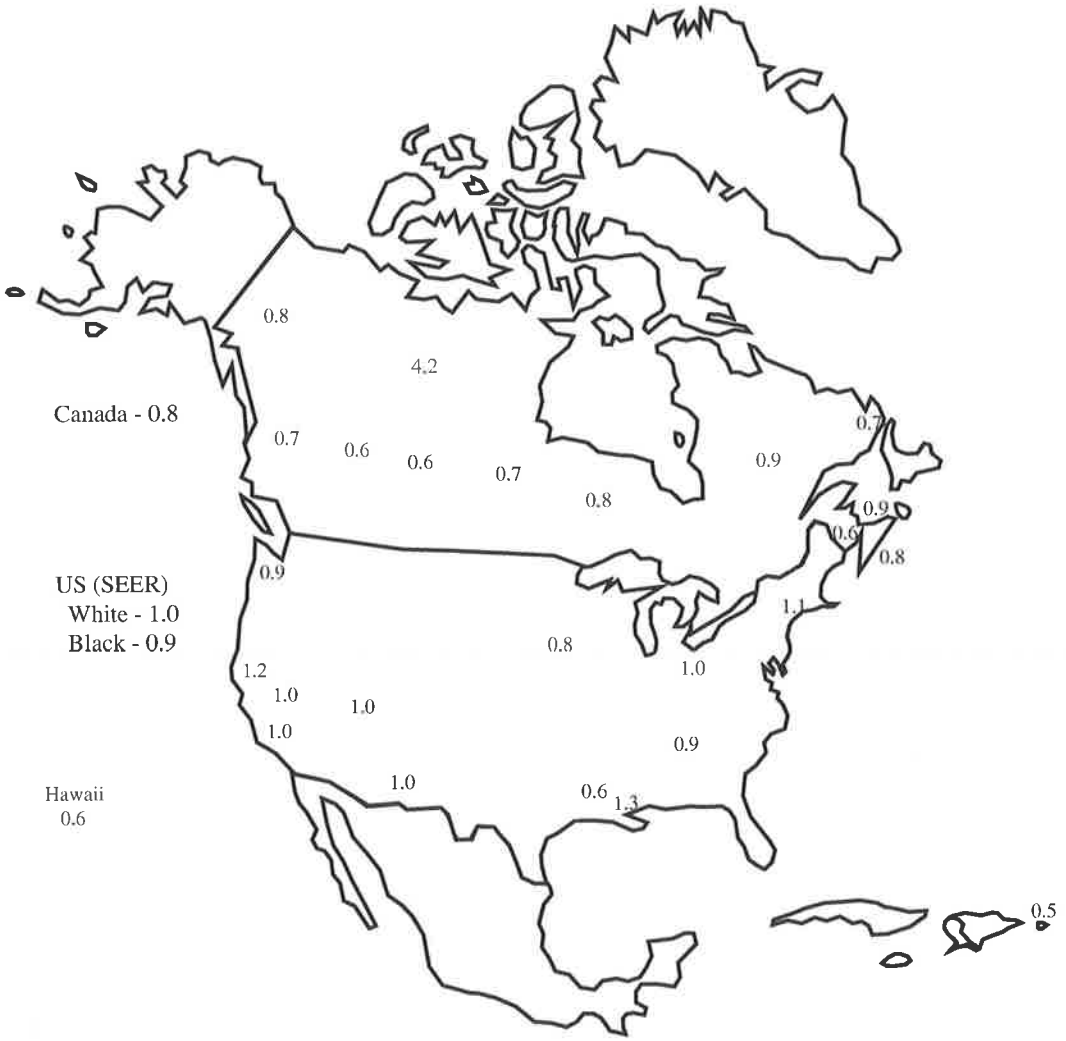

Figure 16a. North America. Incidence of salivary gland cancer (142 ICD-9) in white males for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII Edition (1997).

The highest incidence rate in Canada (and one of the highest in the world) is reported in the Northwest Territories (4.2), although it should be noted that this rate is based on a relatively small number of cases. The high rate in the northern regions of Canada has been noted in earlier editions of *Cancer Incidence in Five Continents* (Parkin *et al* 1992) and may be linked to previously reported cases of highly malignant lymphoepithelial adenocarcinomas observed in Alaskan natives in the 1960's and 1970's (Blot *et al* 1975; Lanier *et al* 1976). This poorly differentiated tumour was commonly seen in the parotid gland and resulted in significantly increased mortality rates among the natives of Alaska. Merrick *et al* (1986) in a study of on salivary gland carcinoma in Greenland, reported an incidence rate in males of 3.9 per 100,000 per annum between 1965-1974. No subsequent data for this region were found.

The United States SEER rate for salivary gland tumours in males is 1.0 per 100,000 per annum, with only a few centres reporting rates higher than this figure. Muir and Weiland (1995), in an extensive review of upper aerodigestive tract cancers, reported a complex picture. These investigators found that some types of salivary gland tumours are increasing, while others are decreasing. Devesa *et al* (1995) reported an overall decrease in mortality from salivary gland tumours in the United States from 1975-1991, although incidence rates were stable. In a more specific study of data from the San Francisco-Oakland registry between 1973-1988, Horn-Ross *et al* (1991) found a sudden and sustained doubling in the incidence of salivary gland cancer among men only, beginning in 1985. These authors discovered no reason for this increase.

b. Female

The incidence of salivary gland tumours in the female populations of North America (Figure 16b) is quite variable, although all regions report incidence rates lower than the corresponding male rates. As with the male rate, the Northwest Territories of Canada reports the highest incidence, but this rate of 2.0 per 100,000 per annum is based on a small number of cases. Merrick *et al* (1986) reported a female incidence rate of 7.7 per 100,000 per annum in Greenland between 1965-1974. At this time, this was approximately double the male rate and the authors commented that "it is well known that the incidence of SGC (Salivary Gland Carcinoma) in Eskimos is twice as high in women as in men both in Alaska and in Greenland."

The incidence of salivary gland tumours among females in the United States is low and, according to Devesa *et al* (1995), both incidence and mortality rates have fallen between 1975-1991.

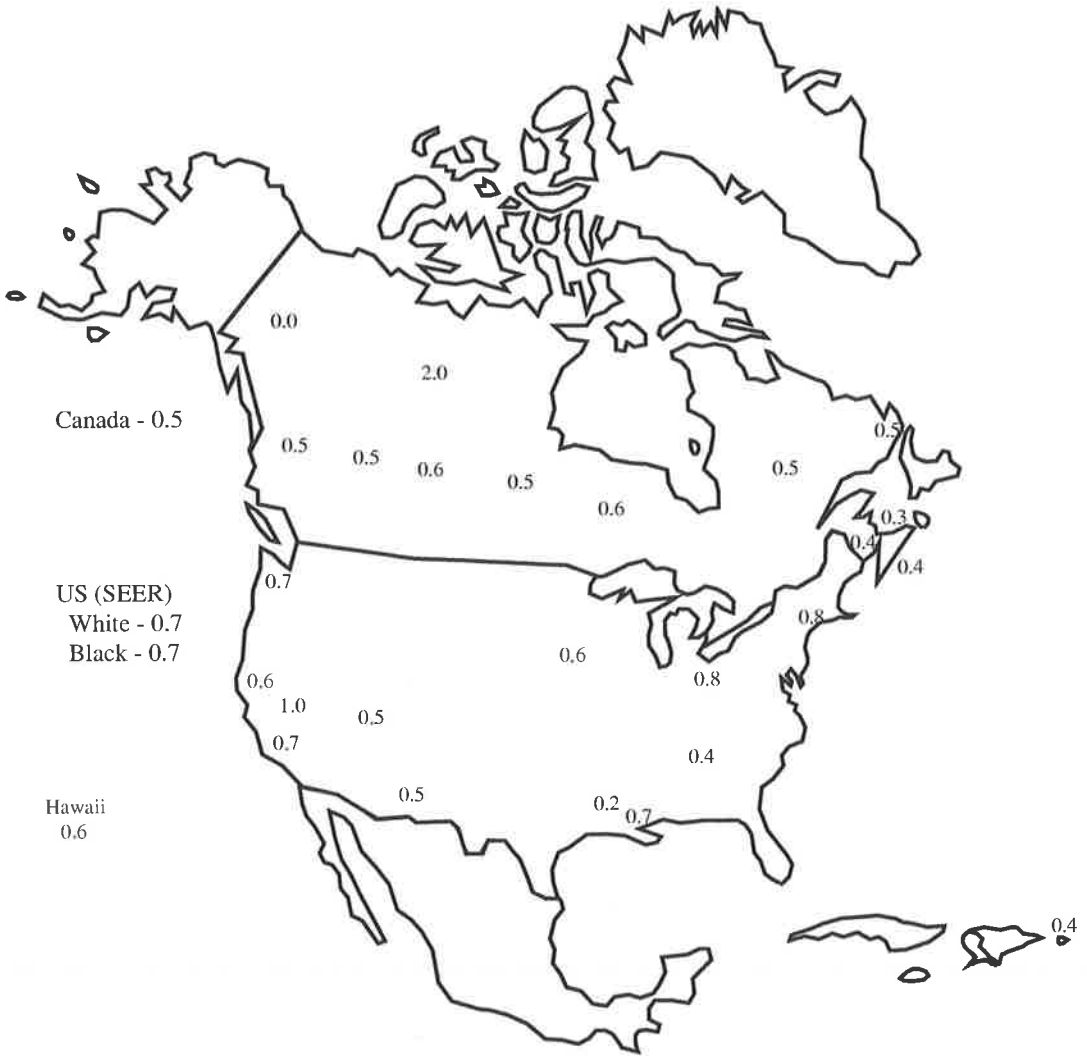

Figure 16b. North America. Incidence of salivary gland cancer (142 ICD-9) in white females for selected regions of North America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII Edition (1997).

South America

a. Male

The incidence of salivary gland cancer in South American males (Figure 17a) is low with few regions reporting rates over 1.0 per 100,000 per annum. Cali, Columbia, reported a higher incidence rate of 2.1 per 100,000 per annum for salivary gland cancer during the 1960's (Doll *et al* 1966), but this has not been repeated recently.

Figure 17a. South America. Incidence of salivary gland cancer (142 ICD-9) in white males for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

b. Female

The incidence of salivary gland tumours in females in South America (Figure 17b) is low, but it is interesting to observe that in some regions female rates are the same as the corresponding male rates, while in Trujillo, Peru, the incidence is greater.

Figure 17b. South America. Incidence of salivary gland cancer (142 ICD-9) in white females for selected regions of South America. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Europe

a. Male

The incidence of salivary gland cancer in males in Europe (Figure 18a) is generally low with only Southern Ireland (1.2) and some regions of Italy reporting rates greater than 1.0 per 100,000 per annum.

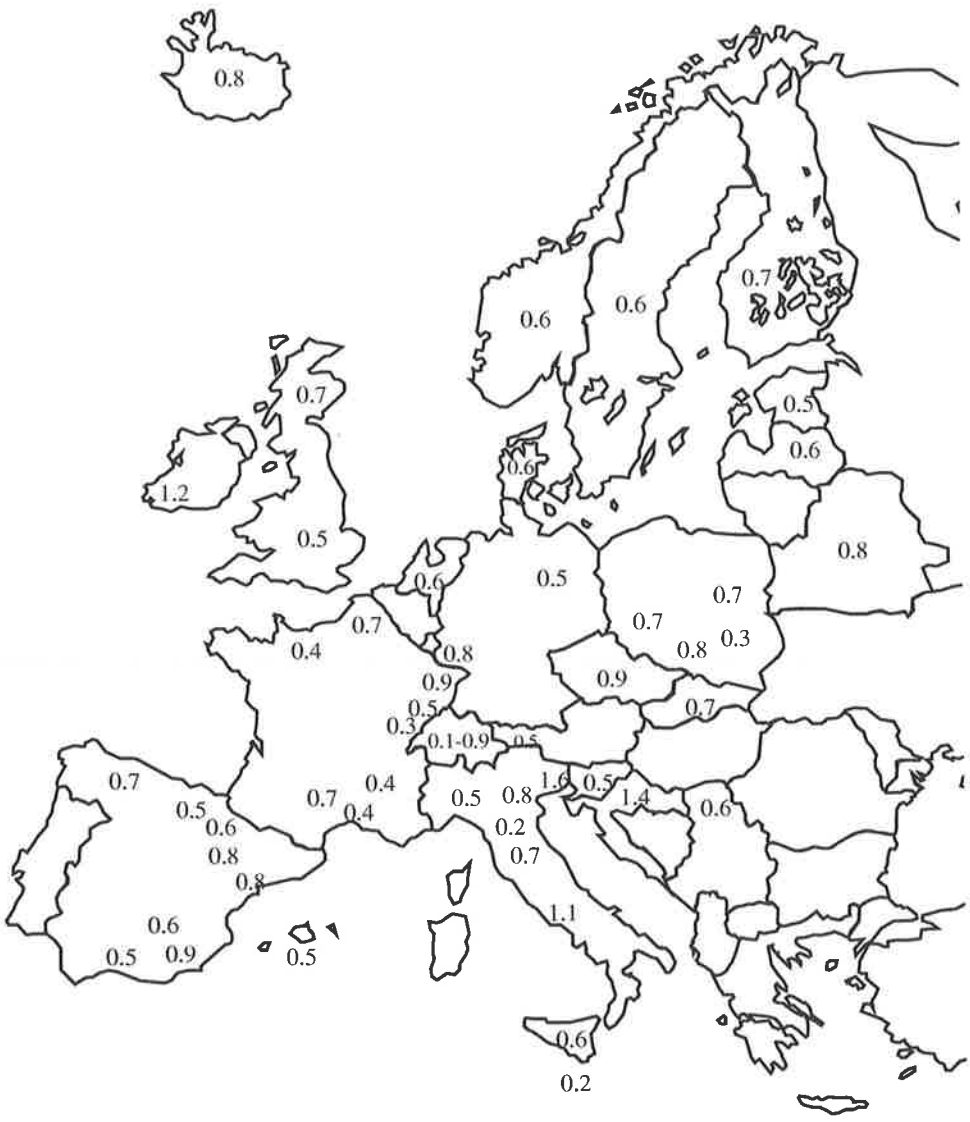

Figure 18a. Europe. Incidence of salivary gland cancer (142 ICD-9) in white males for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Although some regions of France have reported consistently high rates since the late 1970's, the latest data confirms that the incidence appears to be stable or decreasing. This trend is supported by data for cancer mortality in France between 1950-1985 (Hill *et al* 1991) which showed only minor changes in mortality from salivary gland tumours. It is interesting to observe that in 1978 the urban incidence rate in the Doubs region was 3.5 per 100,000 per annum while the rural rate was only 1.3 per 100,000 per annum, giving an overall incidence of 2.7 per 100,000 per annum (Waterhouse *et al* 1982). Between 1978-1982 (Muir *et al* 1987), however, the overall incidence had fallen to 1.6 per 100,000 per annum, due mainly to a significant drop in the urban rate (1.5) that masked a rise in the rural rate (1.9).

In an extensive study of malignant salivary gland tumours in Sweden over the past 30 years, Ostman *et al* (1997) reported a relatively stable overall incidence rate in males, while noting variations in specific glands/subsites. Another interesting observation comes from Scotland between 1983-1987 (Parkin *et al* 1992) where the overall rate of 0.8 per 100,000 per annum masks a much higher incidence of 2.2 per 100,000 per annum in the Northeast region. This is a somewhat unusual finding since previous data (Waterhouse *et al* 1982; Muir *et al* 1987) demonstrated consistently higher rates in the Southeast region. Elsewhere in the United Kingdom, the incidence of salivary gland cancer seems low and stable, with Hindle and Nally (1991) reporting a decrease in the number of cases in England and Wales between 1962-1967 and 1980-1984. A recent observation (Swerdlow *et al* 1995a) was an increased risk of salivary gland cancer (along with other forms of oral cancer), in English and Welsh migrants to New Zealand.

b. Female

The incidence of salivary gland tumours in European females (Figure 18b) is low with few regions reporting rates greater than 0.5 per 100,000 per annum. The reported incidence rate in Malta (1.1) is much higher than the corresponding male rate, but it is based on a small number of cases.

Figure 18b. Europe. Incidence of salivary gland cancer (142 ICD-9) in white females for selected regions of Europe. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

In a detailed study of malignant salivary gland tumours in Sweden between 1960-1989, Ostman *et al* (1997) showed that the overall female incidence rates had remained stable over that time period, with minor variations between different subsites. Hill *et al* (1991) showed that, in France, the mortality from salivary gland tumours in females had remained stable between 1950-1985.

In England and Wales, Hindle and Nally (1991) demonstrated a drop of almost 50% in the incidence of malignant salivary gland neoplasms in females between 1962-1967 and 1980-1984.

Asia

a. Male

In Asia the rate of salivary gland cancer in males (Figure 19a) is low with only Korea (1.6) and Manila (1.2) reporting an incidence rate greater than 1.0 per 100,000 per annum. The elevated Korean figure is based on a small number of cases. The rates in India, China, Japan and Thailand are all less the 0.8 per 100,000 per annum.

Figure 19a. Asia. Incidence of salivary gland cancer (142 ICD-9) in males for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Su *et al* (1999) reported an increase in age-adjusted mortality of salivary gland cancer in Japanese males from 1950-1994, but this trend appears to have plateaued since 1980.

b. Female

The incidence of salivary gland tumours in Asian females (Figure 19b) shows a variable pattern. In some regions rates are higher than the corresponding male rates, but generally they are less. The elevated rate reported for the Indian female population of Singapore (1.3) is based on a small number of cases.

Figure 19b. Asia. Incidence of salivary gland cancer (142 ICD-9) in females for selected regions of Asia. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

Oceania

a. Male

The incidence of salivary gland cancer in males in Oceania (Figure 20a) shows an incidence rate range from 0.4 per 100,000 per annum in Tasmania to 1.2 per 100,000 per annum in the Non-Maori (New Zealand) population.

Figure 20a. Oceania. Incidence of salivary gland cancer (142 ICD-9) in white males for selected regions of Oceania. Average annual age-standardised rates per 100,000 population (Standard World Population).
Source: Parkin *et al*, Cancer Incidence in Five Continents, Volume VII (1997).

The South Australian situation is interesting with a higher rate of 1.5 per 100,000 per annum reported both in 1977 (Waterhouse *et al* 1982) and between 1978-1982 (Muir *et al* 1987). Roder and Wilson (1983) also reported an elevated rate of 1.7 per 100,000 per annum for salivary gland cancer in South Australia between 1977-1980. More

Methods

This study examined the principal oral cancer sites using the classification outlined in *The International Classification of Diseases, Ninth Edition* (WHO 1977) namely:

Lip	140, 173.0
Tongue	141
Major Salivary Glands	142
Gum	143
Floor of mouth	144
Mouth, other parts	145

The raw data for each site were analysed using Excel ™(*Microsoft*) software for distribution by sex and age at diagnosis. Simultaneously all cases were also analysed by pathological type or morphology using the coding from *The International Classification of Diseases for Oncology, Second Edition* (WHO 1990). These findings are presented in both tabular and graphical form.

Following guidelines recommended by the International Agency for Cancer Research (IACR) (Esteve *et al* 1994), age-specific and age-standardised (world standard population) incidence and mortality rates were also calculated. A worked example of the calculation of population-based incidence rates for lip cancer in 1996 is presented in Table 5.

Poisson regression analyses were carried out for each site to assess time trends in incidence and mortality rates during the period 1977-1996. The predictor values used in these multivariate analyses were calendar year of diagnosis or death as appropriate and corresponding age expressed in five-year categories. An example of this calculation for lip cancer incidence in South Australian males between 1977-1996 is presented as Appendix IV.

Excel ™(*Microsoft*) software was used to construct graphs of the various parameters for each site. Excel ™(*Microsoft*) - generated logarithmic trendlines were added to the graphs to give a general indication of trends in incidence and mortality over the 20 year period.

Chapter Four

Results

4.1 Oral Cancer 140-5 (ICD-9)

A total of 4054 cases of oral cancer (140-5 ICD-9) were reported to the South Australian Cancer Registry between 1977-1996. The raw data relating to these cases are summarised in Tables 6-8.

Table 6 is a summary of the raw data by site (ICD-9) and sex. It shows that 72.9% of all cancers occurred in males with 27.1% found in females. The lip was the most common site of occurrence (67.0%) with the vast majority of these lesions (72.5%) occurring on the lower lip (ICD-9 140.1) (See Table 11).

Tables 7 and 8 present the tumour pathology/morphology for these lesions by sex and site respectively, using the ICD-10 classification coding. Squamous cell carcinoma was the dominant form of malignancy accounting for 87.5% of all oral cancer in South Australia between 1977-1996. If all cases of salivary gland cancer are removed from the data, this figure rises to 93.5%.

The average age at diagnosis for oral cancer in South Australia between 1977-1996 was 59.3 years in males and 66.0 years in females. The age distribution at diagnosis for oral cancer is shown in Figure 21.

SITE	Male	Female	TOTAL
140, 173.0 Malignant neoplasm of the lip	**2095**	**621**	**2716 (67.0%)**
140.0 Upper lip, vermilion border	108	102	210
140.1 Lower lip, vermilion border	1598	372	1970
140.9 Lip, unspecified	235	74	309
173.0 Skin of lip	154	73	227
141 Malignant neoplasm of the tongue	**302**	**152**	**454 (11.2%)**
141.0 Base of tongue	56	14	70
141.1 Dorsal surface of tongue	5	3	8
141.2 Tip and lateral border of tongue	72	41	113
141.3 Ventral surface of tongue	10	12	22
141.9 Tongue, unspecified	159	82	241
142 Malignant neoplasm of major salivary glands	**190**	**112**	**302 (7.4%)**
142.0 Parotid gland	147	91	238
142.1 Submandibular gland	28	12	40
142.2 Sublingual gland	1	1	2
142.8 Other major salivary glands (overlapping sites)	2	2	4
142.9 Salivary gland, unspecified	12	6	18
143 Malignant neoplasm of gum	**39**	**31**	**70 (1.7%)**
143.0 Upper gum	1	6	7
143.1 Lower gum	19	15	34
143.9 Gum, unspecified	19	10	29
144 Malignant neoplasm of floor of mouth	**166**	**60**	**226 (5.6%)**
144.9 Floor of mouth, part unspecified	166	60	226
145 Malignant neoplasm of other and unspecified parts of mouth	**164**	**122**	**286 (7.1%)**
145.0 Cheek mucosa	39	36	75
145.5 Palate, unspecified	69	43	112
145.8 Other unspecified parts of mouth (overlapping sites)	35	19	54
145.9 Mouth, unspecified	21	24	45
TOTAL	**2956 (72.9%)**	**1098 (27.1%)**	**4054 (100%)**

Table 6. Oral Cancer in South Australia, 1977-1996: Raw data - site/subsite (ICD-9) and sex.

Tumour Pathology/Morphology		Male	Female	TOTAL
M800 Neoplasms, NOS				
8000/3	Neoplasm, malignant	10	14	**14**
M801-M804 Epithelial neoplasms, NOS				
8010/3	Carcinoma, NOS	1		**1**
8020/3	Undifferentiated carcinoma, NOS	11	12	**23**
8030/3		6		**6**
8041/3	Small cell carcinoma, NOS	3	3	**6**
M805-M808 Squamous cell neoplasms				
8051/3	Verrucous carcinoma	7	7	**14**
8052/3	Papillary squamous cell carcinoma		1	**1**
8070/3	Squamous cell carcinoma, NOS	2644	905	**3549**
8071/3	Squamous cell carcinoma, keratinising, NOS	6	4	**10**
8074/3	Squamous cell carcinoma, spindle cell	1	1	**2**
8076/3	Squamous cell carcinoma, microinvasive	5		**5**
8082/3	Lymphoepithelial carcinoma	102	36	**138**
M809-M811 Basal cell neoplasms				
8094/3	Basosquamous carcinoma	1	2	**3**
M812-M813 Transitional cell papillomas and carcinomas				
8123/3	Transitional cell carcinoma	2	1	**3**
M814-M838 Adenomas and adenocarcinomas				
8140/3	Adenocarcinoma, NOS	25	18	**43**
8200/3	Adenoid cystic carcinoma, NOS	22	26	**48**
8201/3	Cribriform carcinoma		1	**1**
8231/3		6	5	**11**
8240/3		1		**1**
8243/3			1	**1**
8260/3	Papillary adenocarcinoma, NOS	1		**1**
8290/3	Oxyphilic adenocarcinoma		3	**3**
8310/3	Clear cell adenocarcinoma, NOS	3	2	**5**
8323/3		1		**1**
8340/3	Papillary carcinoma, papillary variant		1	**1**
M843 Mucoepidermoid neoplasms				
8430/3	Mucoepidermoid carcinoma	57	24	**81**
M844-M849 Cystic, mucinous and serous neoplasms				
8470/3			1	**1**
8480/3		3		**3**
8481/3		2	2	**4**
M850-M854 Ductal, lobular and medullary neoplasms				
8500/3		3		**3**
M855 Acinar cell neoplasms				
8550/3	Acinar cell carcinoma	16	21	**37**
M856-858 Complex epithelial neoplasms				
8560/3	Adenosquamous carcinoma	1	1	**2**
M880 Soft tissue tumours and sarcomas NOS				
8800/3	Sarcoma, NOS		1	**1**
M881-M883 Fibromatous neoplasms				
8830/3	Fibrous histiocytoma, malignant	1		**1**
M889-M892 Myomatous neoplasms				
8900/3	Rhabdomyosarcoma, NOS		1	**1**
M(893-M899 Complex mixed and stromal neoplasms				
8940/3	Mixed tumour, malignant	11	11	**22**
8980/3	Carcinosarcoma, NOS	1		**1**
M906-M909 Germ cell neoplasms				
9070/3			1	**1**
M912-M916 Blood vessel tumours				
9140/3	Kaposi's sarcoma	1		**1**
9150/3	Haemangiopericytoma, malignant		1	**1**
-	Other	2	1	**3**
TOTAL		**2956**	**1098**	**4054**

Table 7. Oral Cancer in South Australia, 1977-1996: Raw data - tumour morphology/ pathology (ICD-O) by sex.

Tumour Pathology/Morphology		Lip	Tongue	Mouth	Salivary	TOTAL
M800 Neoplasms, NOS						
8000/3	Neoplasm, malignant	1	4	6	3	**14**
M801-M804 Epithelial neoplasms, NOS						
8010/3	Carcinoma, NOS		1			**1**
8020/3	Undifferentiated carcinoma, NOS	1	3	1	18	**23**
8030/3				1	5	**6**
8041/3	Small cell carcinoma, NOS		1	1	4	**6**
M805-M808 Squamous cell neoplasms						
8051/3	Verrucous carcinoma	2	1	11		**14**
8052/3	Papillary squamous cell carcinoma		1			**1**
8070/3	Squamous cell carcinoma, NOS	2661	394	452	42	**3549**
8071/3	Squamous cell carcinoma, keratinising, NOS	6	1	3		**10**
8074/3	Squamous cell carcinoma, spindle cell	1	1			**2**
8076/3	Squamous cell carcinoma, microinvasive	4	1			**5**
8082/3	Lymphoepithelial carcinoma	34	42	47	15	**138**
M809-M811 Basal cell neoplasms						
8094/3	Basosquamous carcinoma	3				**3**
M812-M813 Transitional cell papillomas and carcinomas						
8123/3	Transitional cell carcinoma				3	**3**
M814-M838 Adenomas and adenocarcinomas						
8140/3	Adenocarcinoma, NOS	1		13	29	**43**
8200/3	Adenoid cystic carcinoma, NOS		1	14	33	**48**
8201/3	Cribriform carcinoma				1	**1**
8231/3					11	**11**
8240/3					1	**1**
8243/3				1		**1**
8260/3	Papillary adenocarcinoma, NOS				1	**1**
8290/3	Oxyphilic adenocarcinoma				3	**3**
8310/3	Clear cell adenocarcinoma, NOS			3	2	**5**
8323/3					1	**1**
8340/3	Papillary carcinoma, papillary variant			1		**1**
M843 Mucoepidermoid neoplasms						
8430/3	Mucoepidermoid carcinoma			16	65	**81**
M844-M849 Cystic, mucinous and serous neoplasms						
8470/3				1		**1**
8480/3				1	2	**3**
8481/3			1	1	2	**4**
M850-M854 Ductal, lobular and medullary neoplasms						
8500/3					3	**3**
M855 Acinar cell neoplasms						
8550/3	Acinar cell carcinoma			4	33	**37**
M856-858 Complex epithelial neoplasms						
8560/3	Adenosquamous carcinoma			2		**2**
M880 Soft tissue tumours and sarcomas NOS						
8800/3	Sarcoma, NOS				1	**1**
M881-M883 Fibromatous neoplasms						
8830/3	Fibrous histiocytoma, malignant				1	**1**
M889-M892 Myomatous neoplasms						
8900/3	Rhabdomyosarcoma, NOS			1		**1**
M893-M899 Complex mixed and stromal neoplasms						
8940/3	Mixed tumour, malignant			1	21	**22**
8980/3	Carcinosarcoma, NOS				1	**1**
M906-M909 Germ cell neoplasms						
9070/3		1				**1**
M912-M916 Blood vessel tumours						
9140/3	Kaposi's sarcoma			1		**1**
9150/3	Haemangiopericytoma, malignant				1	**1**
-	Other	1	1	1		**3**
TOTAL		**2716**	**454**	**582**	**302**	**4054**

Table 8. Oral Cancer in South Australia, 1977-1996: Raw data - tumour morphology/ pathology (ICD-O) by site.

	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	0	1	10	25	75	113	126	189	196	263	362	385	400	358	249	204	**2956**
Female	1	4	3	7	18	25	32	52	45	52	65	118	153	135	156	232	**1098**
TOTAL	1	5	13	32	93	138	158	241	241	315	427	503	553	493	405	436	**4054**

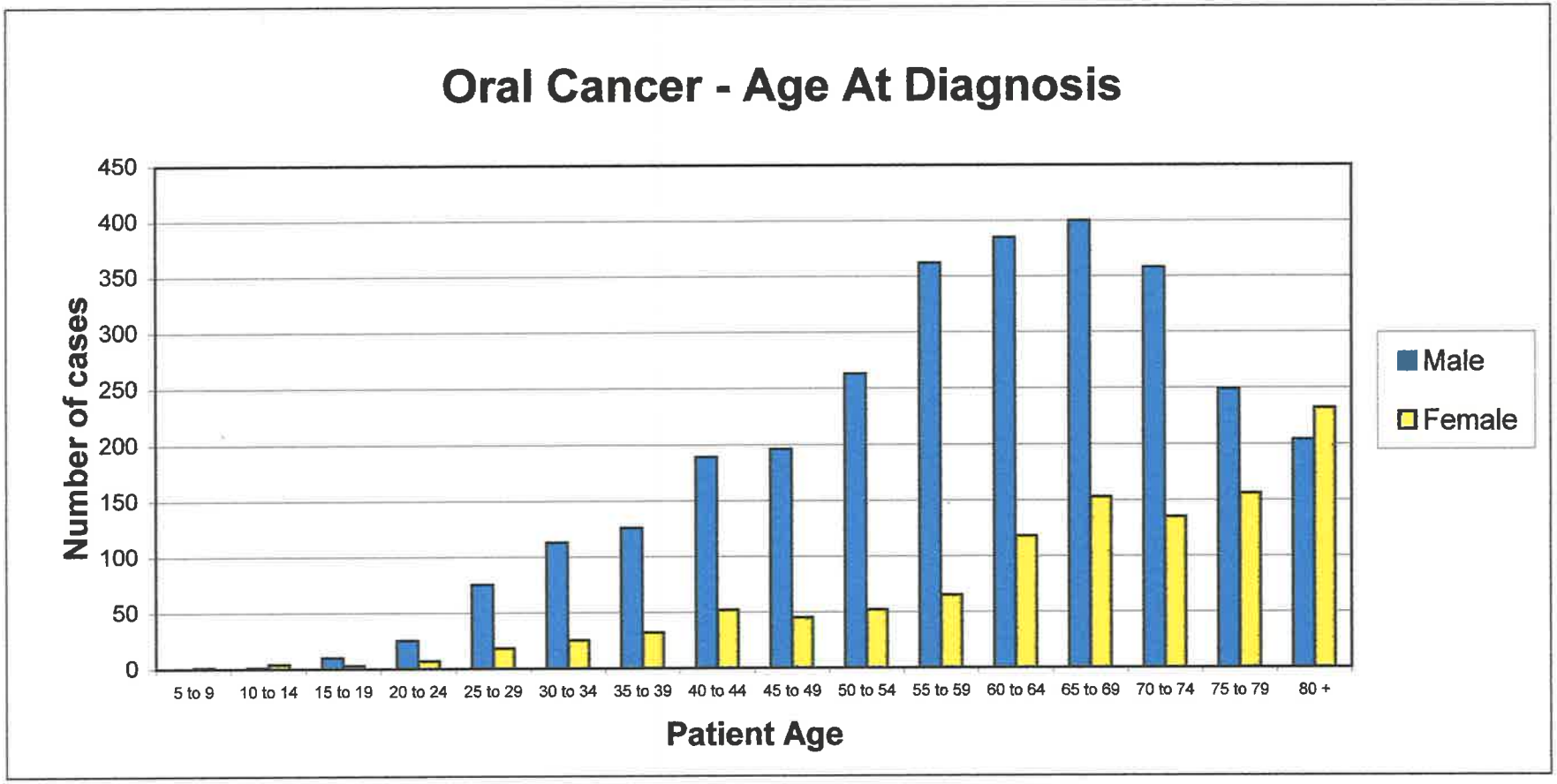

Figure 21. Oral cancer in South Australia, 1977-1996 : Age at Diagnosis (Tabulated data shows actual number of cases).

4.1.1 Oral Cancer Incidence

Incidence trends for oral cancer in South Australia between 1977-1996 are presented in Figures 22-24. Figure 22 provides crude and age-standardised rates for both males and females. Both males and females show a significant increase in oral cancer incidence as subject age rises (P<0.0001). While there is an upward trend in oral cancer incidence in males between 1977-1996, this was not significant (P=0.2744). In females, however, there was a significant increase in oral cancer incidence over the 20 year period (P<0.0001). The rate in 1977 was 1.86 per 100,000 per annum while in 1996 it had risen to 7.26 per 100,000 per annum.

Figures 23 and 24 present age-standardised incidence rates for oral cancer by site for males and females respectively.

Table 9 presents the male/female incidence ratios for oral cancer in South Australia between 1977-1996.

SITE (ICD-9)	1977-1981	1982-1986	1987-1991	1992-1996
Lip (140)	5.32	4.78	4.57	3.42
Tongue (141)	2.17	2.17	2.52	3.07
Mouth (143-5)	2.96	3.03	1.77	1.93
Salivary gland (142)	3.17	3.37	1.14	1.98
All Sites (140-145)	**4.47**	**3.82**	**3.26**	**2.98**

Table 9. Oral Cancer in South Australia, 1977-1996: Male/female incidence ratios (Calculated from age-standardised incidence rates).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	16.32	15.88	13.64	14.65	20.47	19.60	22.26	24.46	24.44	19.77	23.93	23.69	22.56	20.79	22.46	27.07	25.08	20.83	22.00	26.69
Crude female	2.50	5.12	5.39	4.61	5.72	6.12	7.83	7.90	6.25	6.05	8.42	9.33	8.25	11.49	8.35	10.06	8.42	10.94	9.83	12.76
Standardised male	14.85	14.44	11.93	13.33	17.54	16.48	18.57	20.09	20.08	15.81	19.70	19.35	18.18	16.53	17.85	20.83	18.77	15.43	16.93	19.14
Standardised female	1.86	3.64	3.74	3.11	3.77	4.78	5.74	5.08	4.25	4.01	5.28	5.99	5.44	6.44	4.91	5.85	5.43	6.62	5.43	7.26

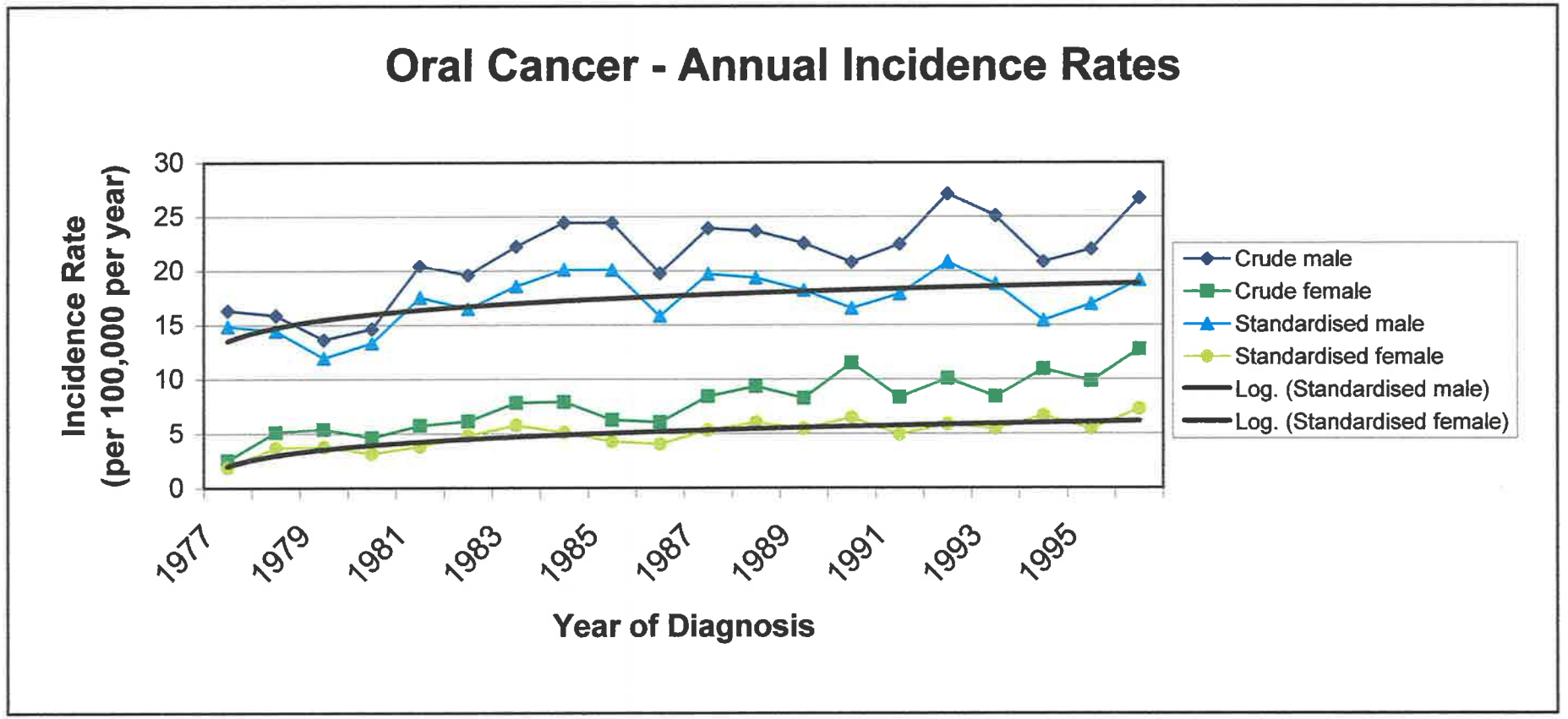

Figure 22. Oral cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

SITE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Lip (140)	9.94	10.59	6.45	8.76	11.06	10.89	14.41	14.36	14.80	10.69	14.91	14.36	12.16	11.83	13.70	15.53	13.90	10.39	12.17	14.08
Tongue (141)	1.65	1.32	1.80	1.50	2.49	2.45	1.23	1.63	1.73	1.73	1.71	1.99	2.41	1.96	1.29	1.56	2.05	1.71	1.26	2.02
Mouth (143-5)	2.26	1.68	1.68	1.76	2.55	1.51	1.91	2.74	2.57	2.54	1.99	2.53	2.62	2.40	2.35	2.57	1.78	1.94	2.13	2.13
Salivary (142)	0.99	0.85	2.01	1.30	1.45	1.62	1.02	1.36	0.98	0.85	1.08	0.47	0.99	0.34	0.52	1.18	1.04	1.39	1.38	0.91
All Sites (140-5)	14.84	14.44	11.94	13.32	17.55	16.47	18.57	20.09	20.08	15.81	19.69	19.35	18.18	16.53	17.86	20.84	18.77	15.43	16.94	19.14

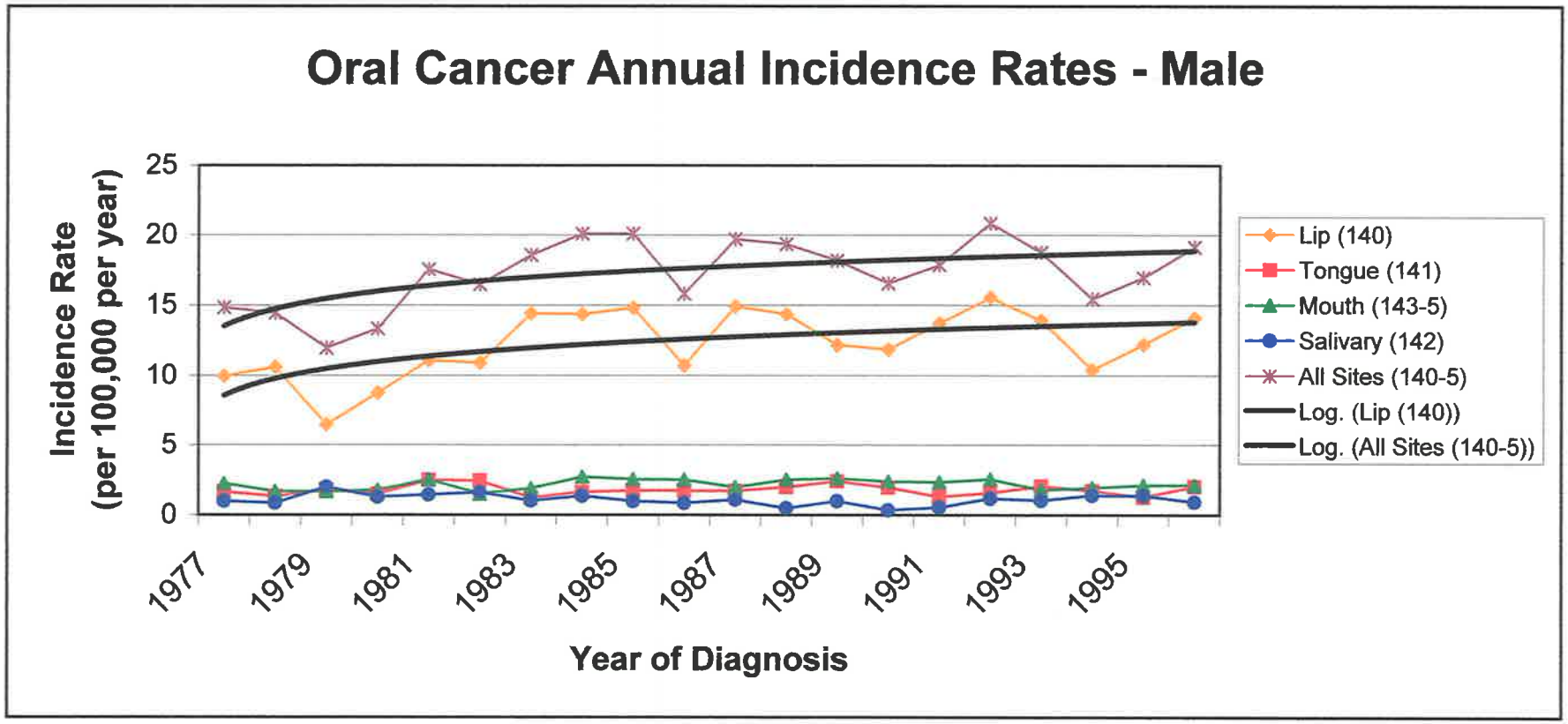

Figure 23. Oral cancer incidence in South Australian males, 1977-1996 : Site trends (Tabulated data - age-standardised rates per 100,000 per annum).

SITE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Lip (140)	0.37	1.36	1.12	0.98	1.88	3.08	2.27	3.21	2.38	2.68	2.32	3.29	2.25	3.85	2.95	3.79	3.73	4.29	2.75	4.74
Tongue (141)	0.65	0.75	0.89	1.06	0.68	0.74	1.03	0.70	0.70	0.88	0.93	0.35	1.16	0.46	0.82	0.29	0.43	0.62	0.52	0.94
Mouth (143-5)	0.26	0.91	1.28	0.33	0.57	0.50	1.37	0.83	0.75	0.27	1.26	1.73	1.34	1.89	0.50	1.07	0.65	1.07	1.53	1.16
Salivary (142)	0.59	0.62	0.45	0.74	0.64	0.47	1.07	0.33	0.41	0.18	0.78	0.62	0.69	0.24	0.63	0.70	0.61	0.63	0.63	0.41
All Sites (140-5)	1.87	3.64	3.74	3.11	3.77	4.79	5.74	5.07	4.24	4.01	5.29	5.99	5.44	6.44	4.90	5.85	5.42	6.61	5.43	7.25

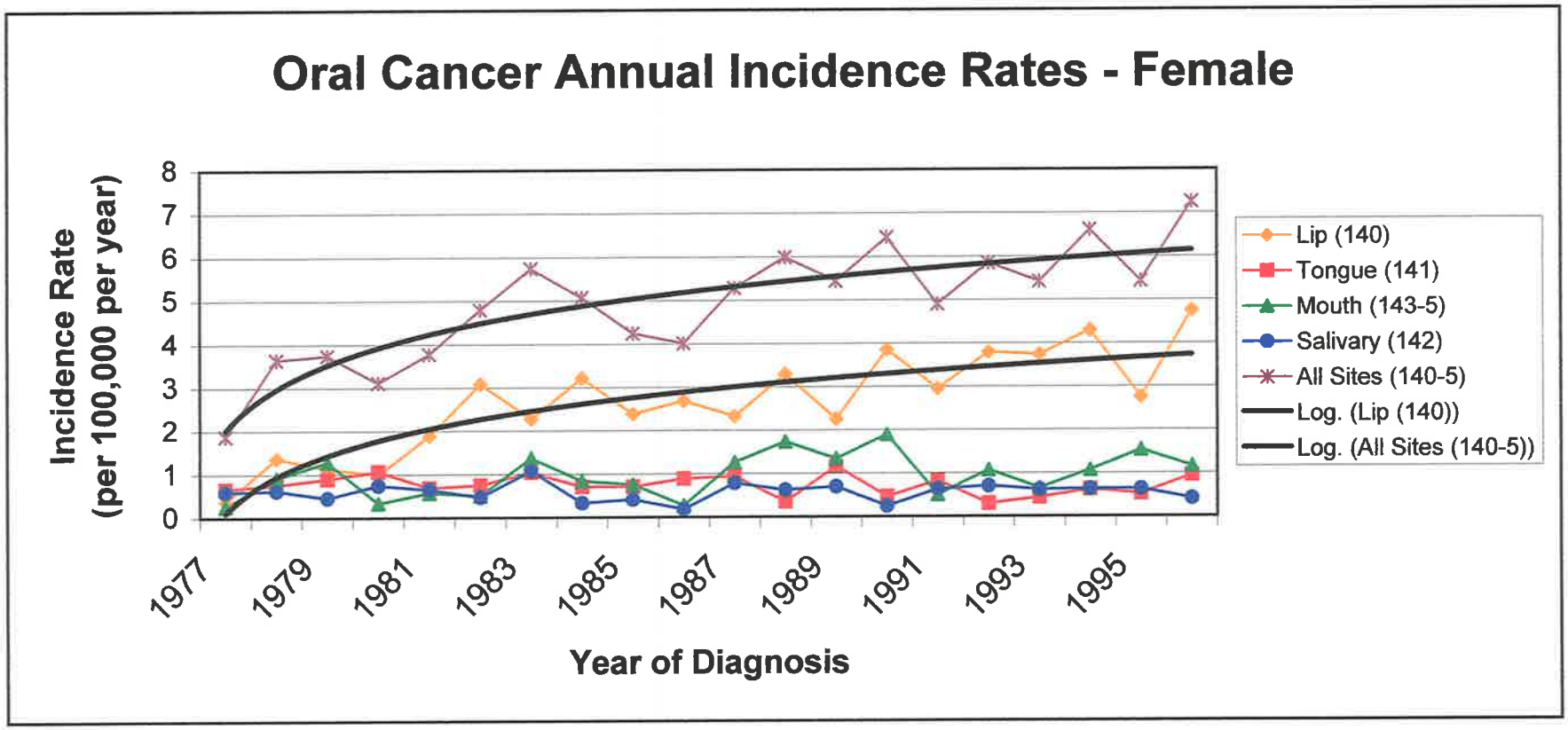

Figure 24. Oral cancer incidence in South Australian females, 1977-1996: Site trends (Tabulated data - age-standardised rates per 100,000 per annum)

4.1.2 Oral Cancer Mortality

The number of deaths from oral cancer in South Australia between 1977-1996 is presented in Table 10.

SITE (ICD-9)	Male	Female	TOTAL
Lip (140)	23	12	**35 (6.2%)**
Tongue (141)	144	54	**198(35.0%)**
Mouth (143-5)	149	77	**226(40.0%)**
Gum (143)	(19)	(18)	(37)
Floor of mouth (144)	(76)	(23)	(99)
Other mouth (145)	(54)	(36)	(90)
Salivary gland(142)	79	27	**106(18.8%)**
All Sites (140-5)	**395 (69.9%)**	**170 (30.1%)**	**565 (100%)**

Table 10. Oral Cancer Mortality in South Australia, 1977-1996: Raw data - site and sex distribution.

Mortality trends for oral cancer in South Australia between 1977-1996 are presented in Figures 25-27. Figure 25 gives crude and age-standardised mortality rates for both males and females. The mortality rate for oral cancer in males has remained stable between 1977-1996. An increase was observed in females, but this was not statistically significant.

Figures 26 and 27 present age-standardised mortality rates for oral cancer by site for males and females respectively.

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	2.04	2.49	2.79	2.93	2.14	3.49	4.06	2.98	2.37	2.04	3.03	2.85	1.13	3.35	3.31	3.18	3.45	3.01	3.69	2.86
Crude female	0.78	1.09	1.23	0.92	0.75	1.19	1.18	0.73	0.73	1.30	0.86	0.99	1.54	1.25	2.05	1.09	1.63	1.62	1.08	2.15
Standardised male	1.86	2.24	2.52	2.61	1.75	2.82	3.29	2.41	1.89	1.64	2.19	2.17	0.90	2.61	2.46	2.24	2.39	1.97	2.50	2.13
Standardised female	0.52	0.75	0.65	0.64	0.44	0.77	0.83	0.42	0.47	0.72	0.58	0.39	0.85	0.61	0.95	0.71	0.84	0.93	0.69	1.01

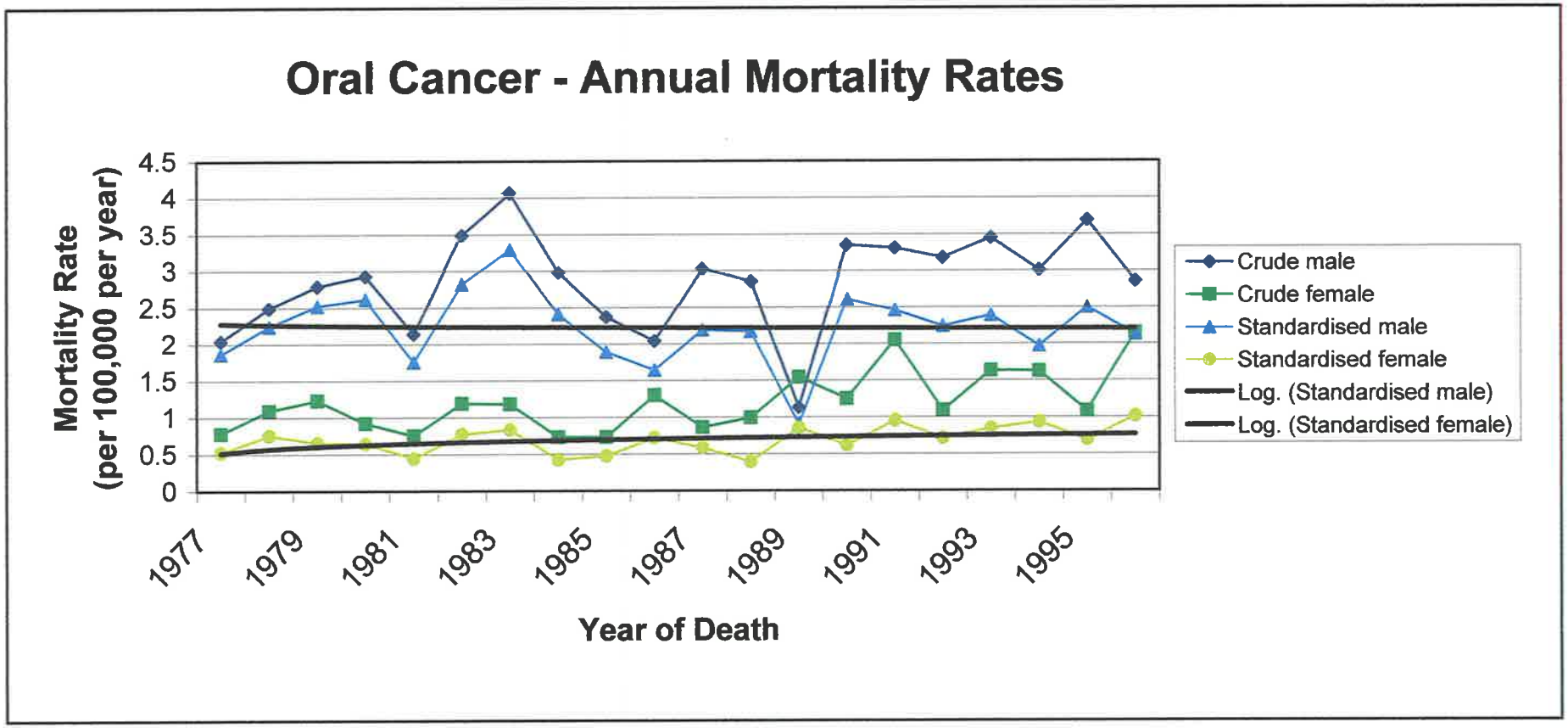

Figure 25. Oral cancer in South Australia, 1977-1996 : Mortality trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

SITE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Lip (140)	0.00	0.41	0.12	0.11	0.00	0.25	0.09	0.25	0.12	0.08	0.12	0.07	0.00	0.00	0.12	0.13	0.06	0.12	0.28	0.10
Tongue (141)	0.88	0.26	1.07	0.80	0.24	1.10	0.89	1.04	0.36	0.56	1.18	0.94	0.24	1.47	0.91	1.09	0.84	0.86	0.95	0.48
Mouth (143-5)	0.71	1.15	0.53	1.10	1.02	0.83	1.20	0.64	0.95	0.61	0.60	0.82	0.66	1.05	1.21	0.78	0.99	0.70	0.69	0.87
Salivary (142)	0.27	0.41	0.80	0.59	0.49	0.63	1.10	0.48	0.47	0.38	0.29	0.33	0.00	0.08	0.22	0.25	0.50	0.29	0.58	0.67
All Sites (140-5)	1.86	2.23	2.52	2.60	1.75	2.81	3.28	2.41	1.90	1.63	2.19	2.16	0.90	2.60	2.46	2.25	2.39	1.97	2.50	2.12

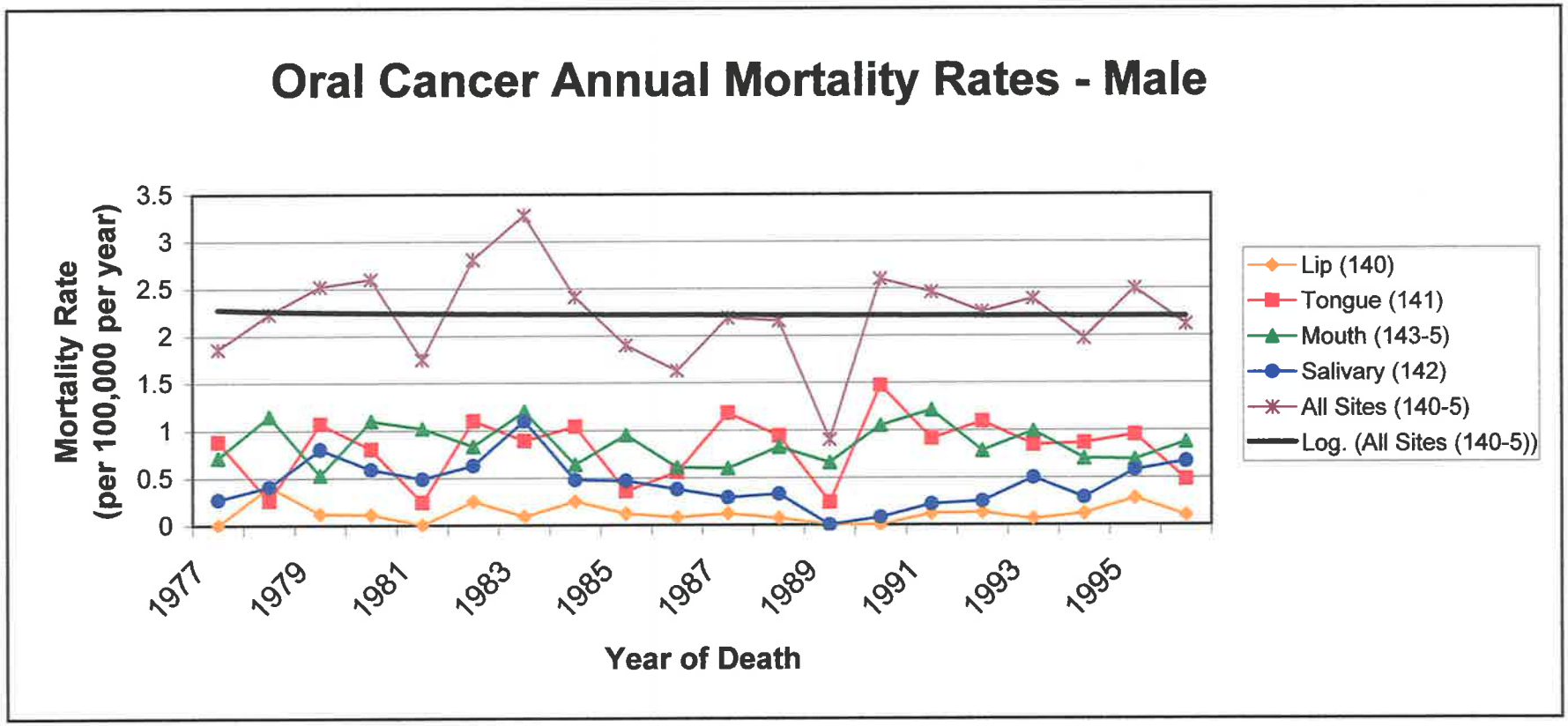

Figure 26. Oral cancer mortality in South Australian males, 1977-1996 : Site trends (Tabulated data - age-standardised rates per 100,000 per annum)

SITE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Lip (140)	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.04	0.04	0.00	0.13	0.05	0.10	0.00	0.14
Tongue (141)	0.24	0.16	0.24	0.32	0.28	0.25	0.51	0.25	0.16	0.18	0.15	0.17	0.13	0.25	0.33	0.30	0.11	0.29	0.16	0.19
Mouth (143-5)	0.14	0.21	0.27	0.32	0.11	0.22	0.11	0.17	0.14	0.21	0.13	0.17	0.56	0.24	0.59	0.28	0.48	0.50	0.36	0.65
Salivary (142)	0.14	0.37	0.07	0.00	0.06	0.30	0.21	0.00	0.17	0.33	0.00	0.04	0.12	0.08	0.04	0.00	0.20	0.04	0.17	0.03
All Sites (140-5)	0.52	0.74	0.64	0.64	0.45	0.77	0.83	0.42	0.47	0.72	0.59	0.38	0.85	0.61	0.96	0.71	0.84	0.93	0.69	1.01

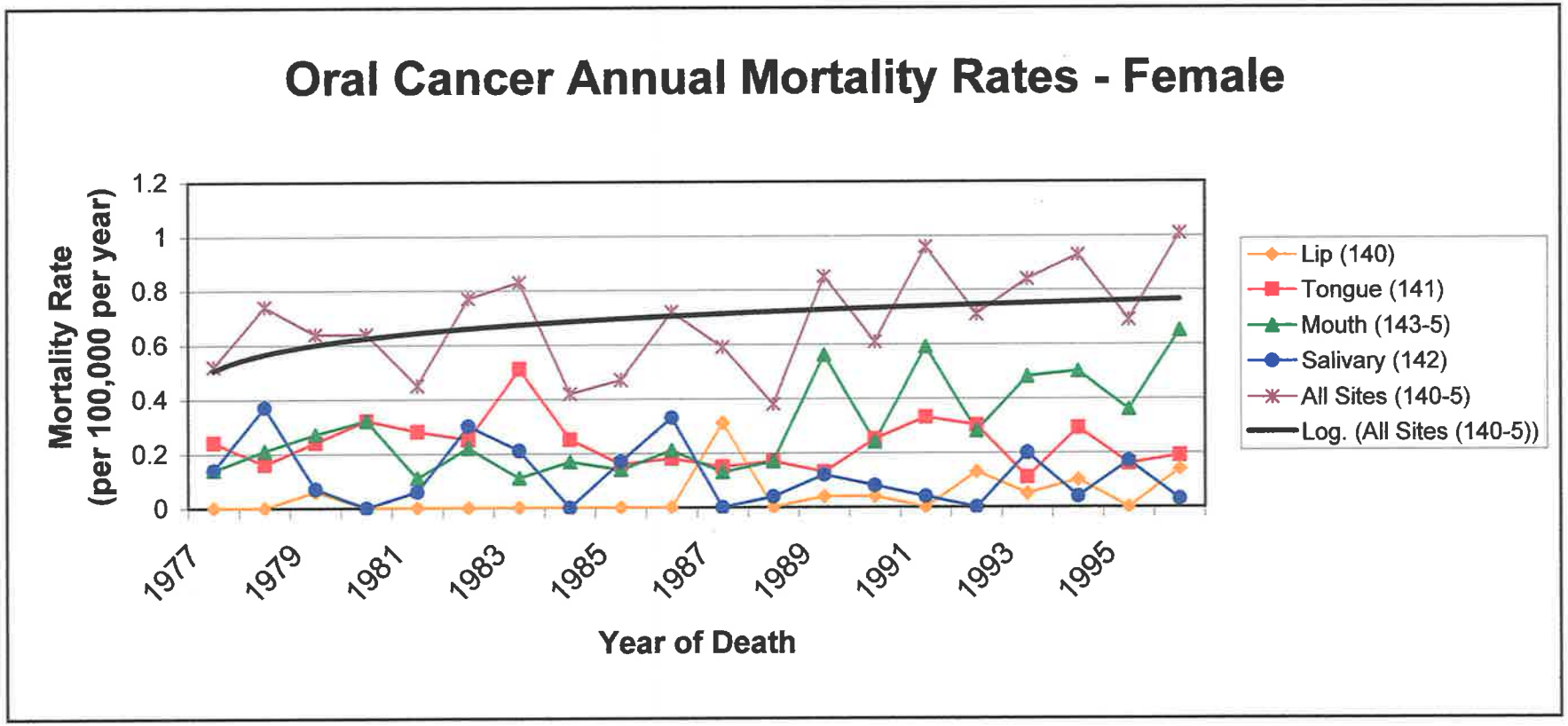

Figure 27. Oral cancer mortality in South Australian females, 1977-1996 : Site trends (Tabulated data - age-standardised rates per 100,000 per annum)

4.2 Lip Cancer 140 (ICD-9)

Figures 28-30 present the data for lip cancer (140 ICD-9) incidence and mortality in South Australia between 1977-1996.

The lip was the most common site for oral cancer (Table 6) comprising 67.0% of all cases. The lower lip (140.1 ICD-9) was the most common subsite accounting for 72.5% of cases. This was followed by lip unspecified (140.9 ICD-9) 11.4%, skin of lip (173.0 ICD-9) 8.4% and upper lip (140.0 ICD-9) 7.7%. Almost all reported malignancies of the lip (98.0%) were squamous cell carcinoma (See Table 8).

The average age of diagnosis for lip cancer was 58.3 years in males and 66.0 years in females. Figure 28 shows the age distribution at diagnosis for lip cancer. Regression analysis showed a highly significant association between lip cancer incidence and increasing patient age for both sexes ($P<0.0001$).

Figure 29 presents the crude and age-standardised incidence rates for lip cancer in South Australia between 1977-1996. The male rate showed a significant increase over the 20 year period ($P=0.0004$), although it appears to have plateaued somewhat in the past decade. In contrast, the female rate has increased significantly since 1977 ($P<0.0001$) and continues to rise at a steady rate.

Mortality from lip cancer in South Australia between 1977-1996 was low and this is reflected in the mortality rates presented as Figure 30. Although the incidence of lip cancer increased over the 20 year period, there were no significant changes in the mortality rates in either sex.

	10 to 15	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	1	9	21	66	96	117	152	148	177	215	254	265	242	181	151	**2095**
Female	0	1	2	11	17	22	36	24	30	29	51	82	76	92	148	**621**
TOTAL	1	8	21	77	113	139	188	172	207	244	305	347	318	273	299	**2716**

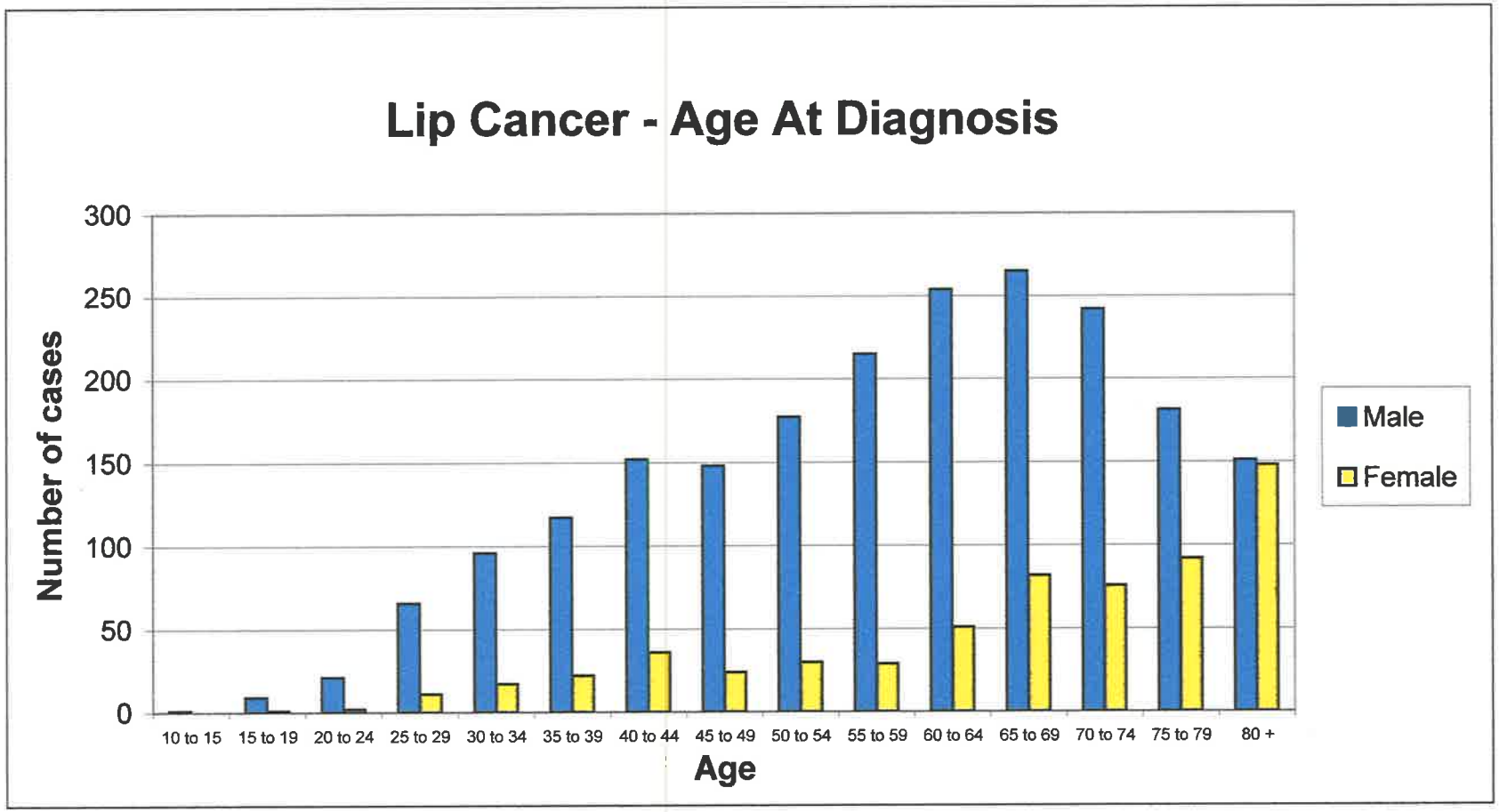

Figure 28. Lip cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	10.83	11.67	7.44	9.40	12.68	12.76	17.15	17.30	17.93	13.52	18.02	17.70	15.09	14.93	17.08	20.17	18.33	14.25	15.85	19.74
Crude female	0.63	1.86	1.70	1.69	2.86	3.88	3.10	5.27	3.34	4.17	3.71	4.95	3.91	7.06	5.34	6.52	5.84	7.70	5.39	8.33
Standardised male	9.94	10.59	6.45	8.76	11.06	10.89	14.41	14.36	14.80	10.69	14.91	14.36	12.16	11.83	13.70	15.53	13.90	10.39	12.17	14.08
Standardised female	0.37	1.36	1.12	0.98	1.88	3.08	2.27	3.21	2.38	2.68	2.32	3.29	2.25	3.85	2.95	3.79	3.73	4.29	2.75	4.74

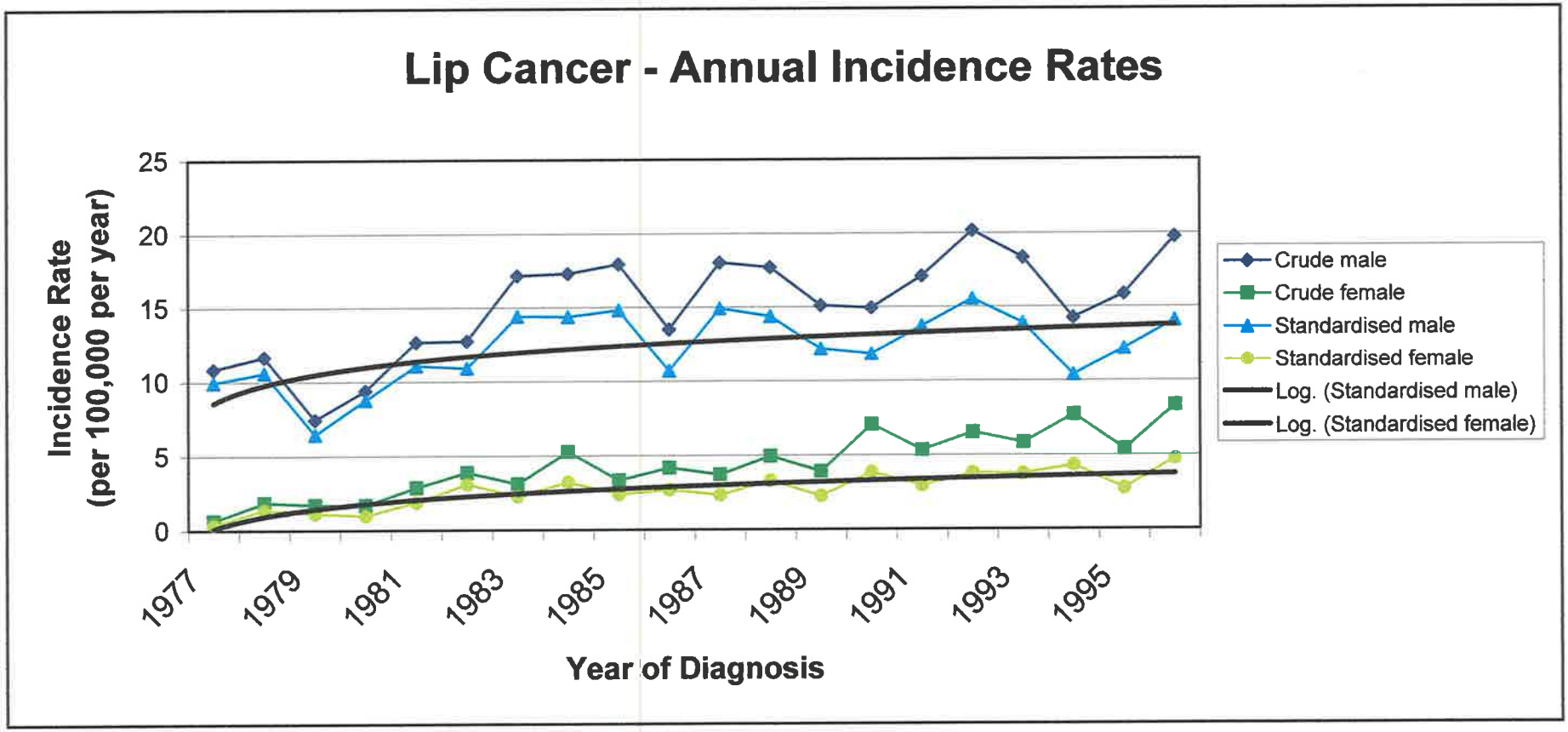

Figure 29. Lip cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	0.00	0.47	0.16	0.15	0.00	0.30	0.15	0.30	0.15	0.15	0.14	0.14	0.00	0.00	0.14	0.28	0.14	0.14	0.41	0.14
Crude female	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.14	0.14	0.00	0.14	0.14	0.27	0.00	0.40
Standardised male	0.00	0.41	0.12	0.11	0.00	0.25	0.09	0.25	0.12	0.08	0.12	0.07	0.00	0.00	0.12	0.13	0.06	0.12	0.28	0.10
Standardised female	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.04	0.04	0.00	0.13	0.05	0.10	0.00	0.14

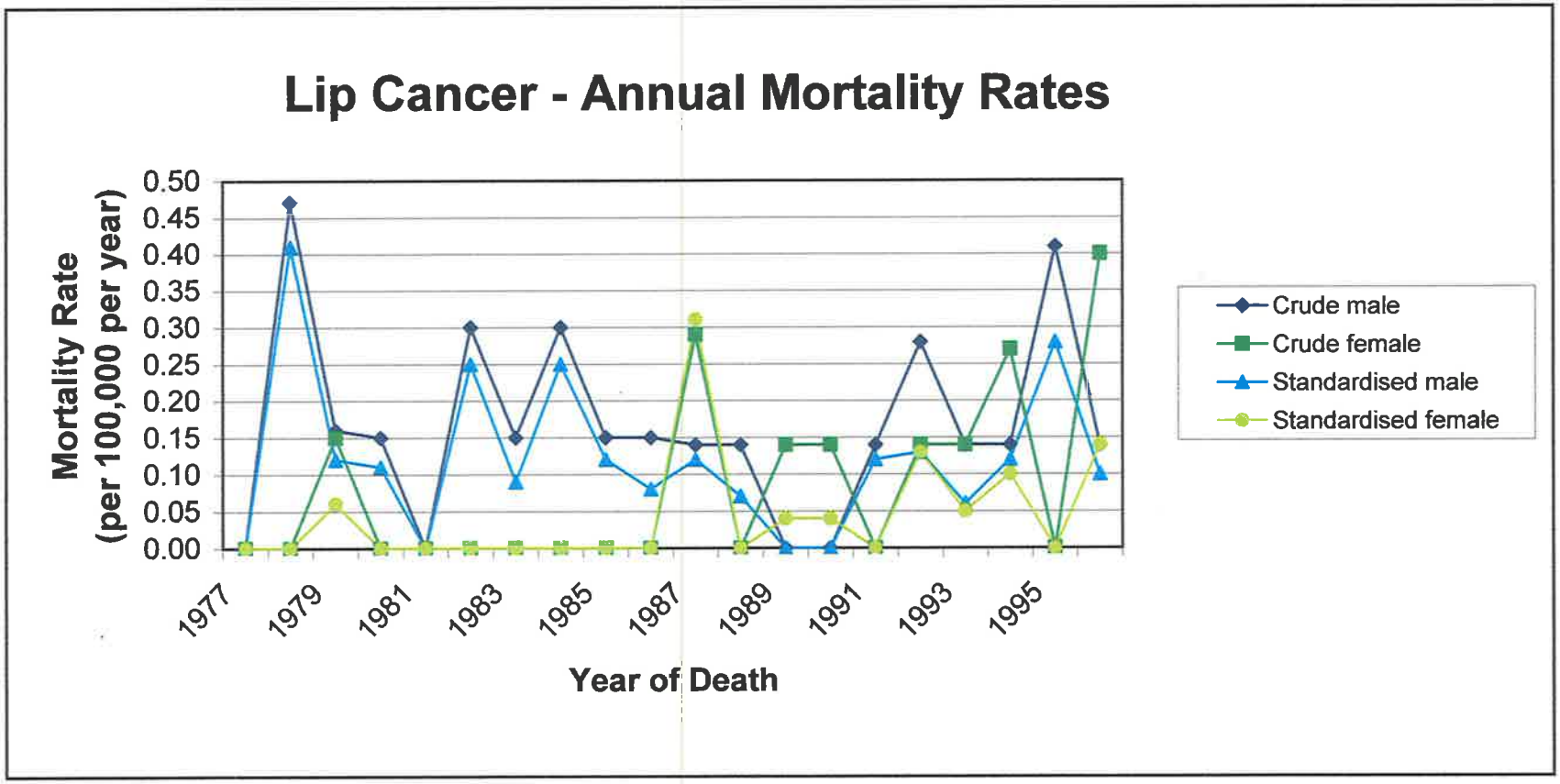

Figure 30. Lip cancer in South Australia, 1977-1996 : Mortality trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

4.3 Tongue Cancer 141 (ICD-9)

Figures 31-33 present the data for tongue cancer (141 ICD-9) incidence and mortality in South Australia between 1977-1996.

The tongue was the most common intraoral site for oral cancer (Table 6) comprising 11.2% of all cases and 43.8% of intraoral malignancies. The tongue unspecified (141.9 ICD-9) was the most commonly reported subsite accounting for 53.1% of cases. This was followed by tip and lateral border of tongue (141.2 ICD-9) 24.9%, base of tongue (141.0 ICD-9) 15.4%, ventral surface of tongue (141.3 ICD-9) 4.8% and dorsal surface of tongue (141.1 ICD-9) 1.8%. While most reported cases of tongue cancer were squamous cell carcinoma (86.8%), there were also a number of cases of lymphoepithelial carcinoma (9.3%) reported at this site (See Table 8).

The average age of diagnosis for tongue cancer was 62.2 years in males and 65.5 years in females. Figure 31 shows the age distribution at diagnosis for tongue cancer. Regression analysis showed a highly significant association between tongue cancer incidence and increasing patient age for both sexes ($P<0.0001$).

The crude and age-standardised incidence rates for tongue cancer in South Australia between 1977-1996 are presented in Figure 32. The rate for males has remained stable over the 20 year period ($P=0.1182$). The female rate did not change significantly between 1977-1996 ($P=0.2345$). Mortality rates from tongue cancer in South Australia between 1977-1996 are presented as Figure 33. There were no significant trends in the mortality rates in either sex between 1977-1996.

	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	1	1	4	2	10	17	32	48	49	59	45	21	13	**302**
Female	2	2	2	5	4	7	6	14	25	21	18	20	26	**152**
TOTAL	3	3	6	7	14	24	38	62	74	80	63	41	39	**454**

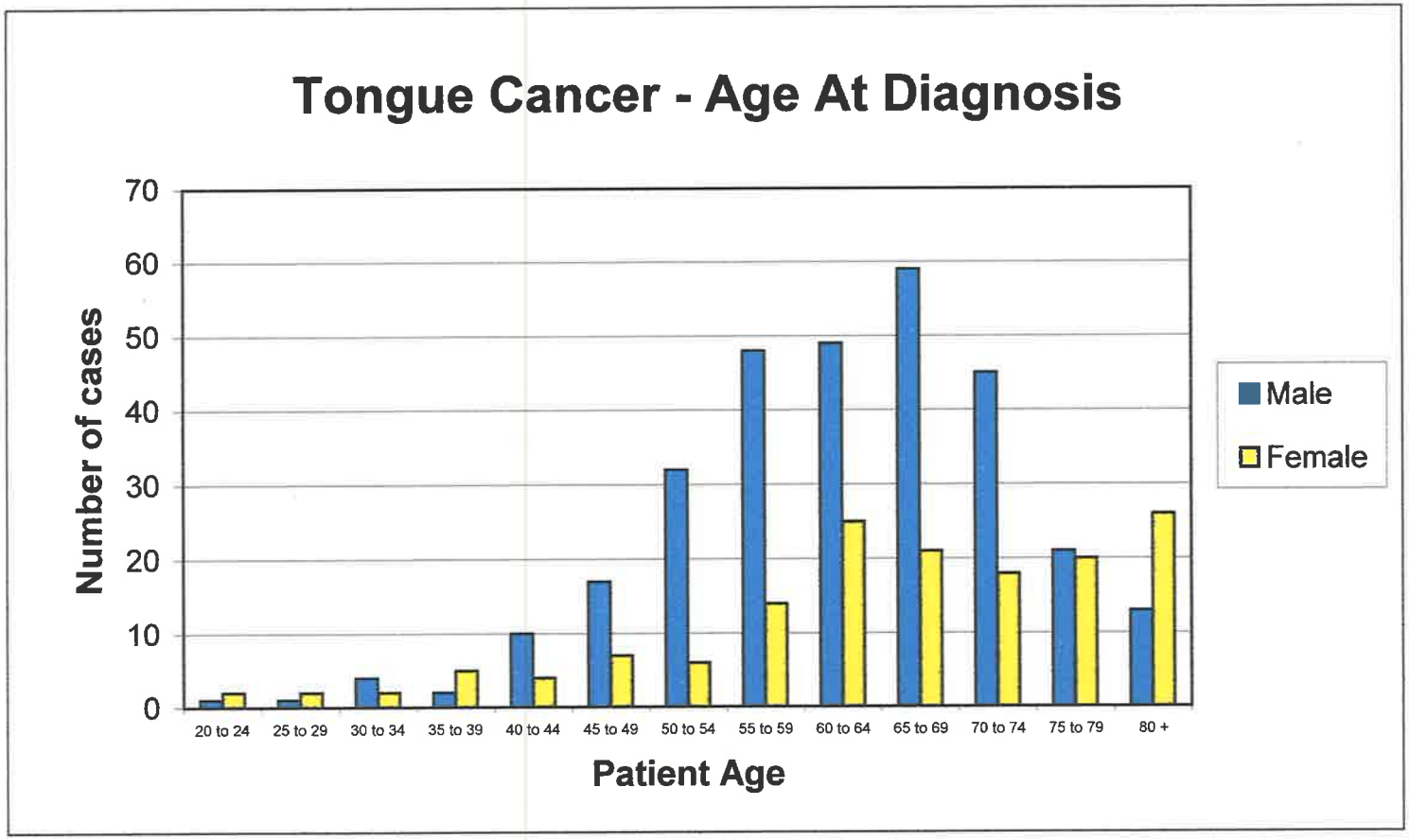

Figure 31. Tongue cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	1.88	1.40	2.02	1.70	2.90	3.04	1.50	2.09	2.22	2.04	2.16	2.43	2.96	2.37	1.79	2.07	2.76	2.19	1.50	2.72
Crude female	0.94	1.09	1.08	1.54	0.90	0.89	1.48	1.02	1.16	1.15	1.43	0.71	1.68	0.83	1.37	0.41	0.68	0.81	1.08	1.61
Standardised male	1.65	1.32	1.80	1.50	2.49	2.45	1.23	1.63	1.73	1.73	1.71	1.99	2.41	1.96	1.29	1.56	2.05	1.71	1.26	2.02
Standardised female	0.65	0.75	0.89	1.06	0.68	0.74	1.03	0.70	0.70	0.88	0.93	0.35	1.16	0.46	0.82	0.29	0.43	0.62	0.52	0.94

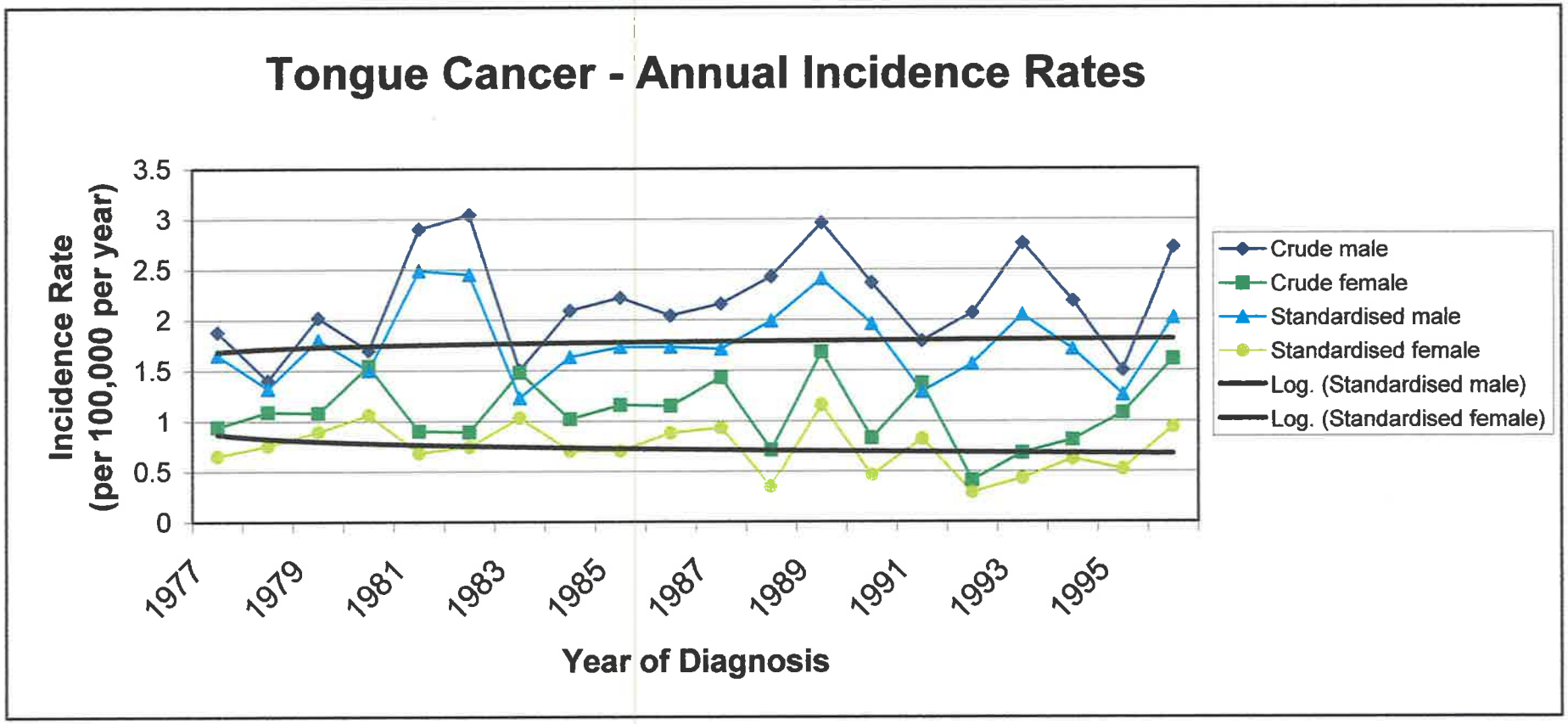

Figure 32. Tongue cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	0.94	0.31	1.09	0.92	0.31	1.37	1.05	1.34	0.44	0.73	1.59	1.28	0.28	1.95	1.24	1.52	1.10	1.37	1.37	0.54
Crude female	0.31	0.16	0.46	0.31	0.45	0.30	0.59	0.44	0.29	0.43	0.29	0.42	0.42	0.42	0.55	0.41	0.27	0.41	0.27	0.40
Standardised male	0.88	0.26	1.07	0.80	0.24	1.10	0.89	1.04	0.36	0.56	1.18	0.94	0.24	1.47	0.91	1.09	0.84	0.86	0.95	0.48
Standardised female	0.24	0.16	0.24	0.32	0.28	0.25	0.51	0.25	0.16	0.18	0.15	0.17	0.13	0.25	0.33	0.30	0.11	0.29	0.16	0.19

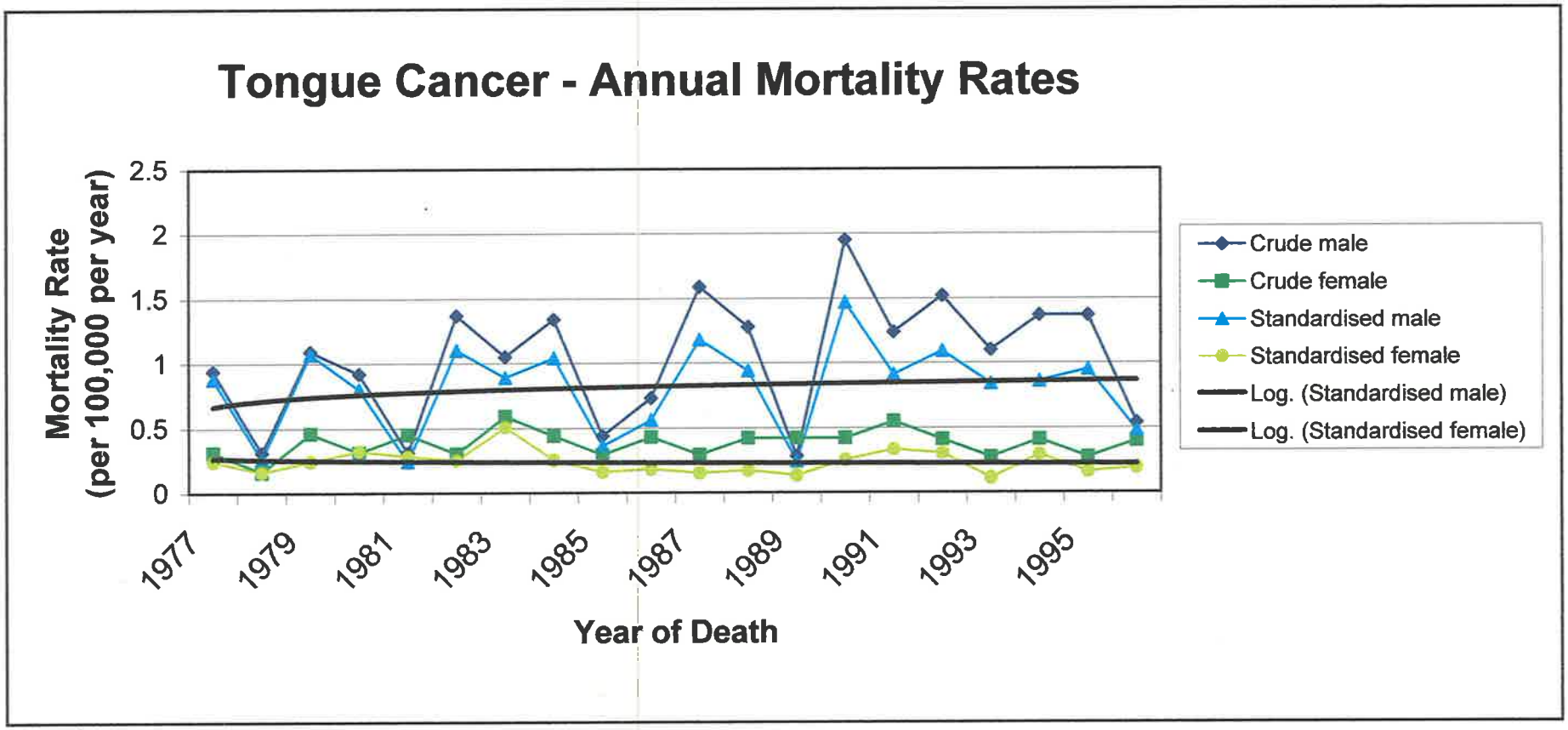

Figure 33. Tongue cancer in South Australia, 1977-1996 : Mortality trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

4.4 Mouth Cancer 143-5 (ICD-9)

Figures 34-36 present the data for mouth cancer (143-5 ICD-9) incidence and mortality in South Australia between 1977-1996. Separate data for specific sites are presented as 4.4.1.

Malignancies of the mouth accounted for 14.4% of all oral cancers (Table 6). Of these cases, 49.1% occurred in other and unspecified parts of the mouth (145 ICD-9), 38.8% on the floor of the mouth (144 ICD-9) and 12.0% on the gum (143 ICD-9). The majority of cases of mouth cancer were squamous cell carcinomas (77.7%) although a number of lymphoepithelial carcinomas (8.1%) were also reported, as were some cases of salivary gland malignancy (mucoepidermoid carcinoma 2.7%, adenoid cystic carcinoma 2.4% and adenocarcinoma NOS 2.2%) (See Table 8).

The average age of diagnosis for mouth cancer was 61.4 years in males and 66.7 years in females. Figure 34 shows the age distribution at diagnosis for tongue cancer. Regression analysis showed highly significant association between mouth cancer incidence and increasing patient age for both sexes ($P<0.0001$).

The crude and age-standardised incidence rates for mouth cancer in South Australia between 1977-1996 are presented in Figure 35. The male incidence rate remained stable over the 20 year period ($P=0.2425$). The female rate did not change significantly between 1977-1996 ($P=0.6756$). Mortality rates from mouth cancer in South Australia between 1977-1996 are presented as Figure 36. There were no significant trends in the mortality rates in either sex between 1977-1996.

	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	0	0	1	1	2	2	4	17	21	39	75	64	56	43	26	18	**369**
Female	1	1	0	2	2	4	1	5	8	10	17	27	33	30	37	35	**213**
TOTAL	1	1	1	3	4	6	5	22	29	49	92	91	89	73	63	53	**582**

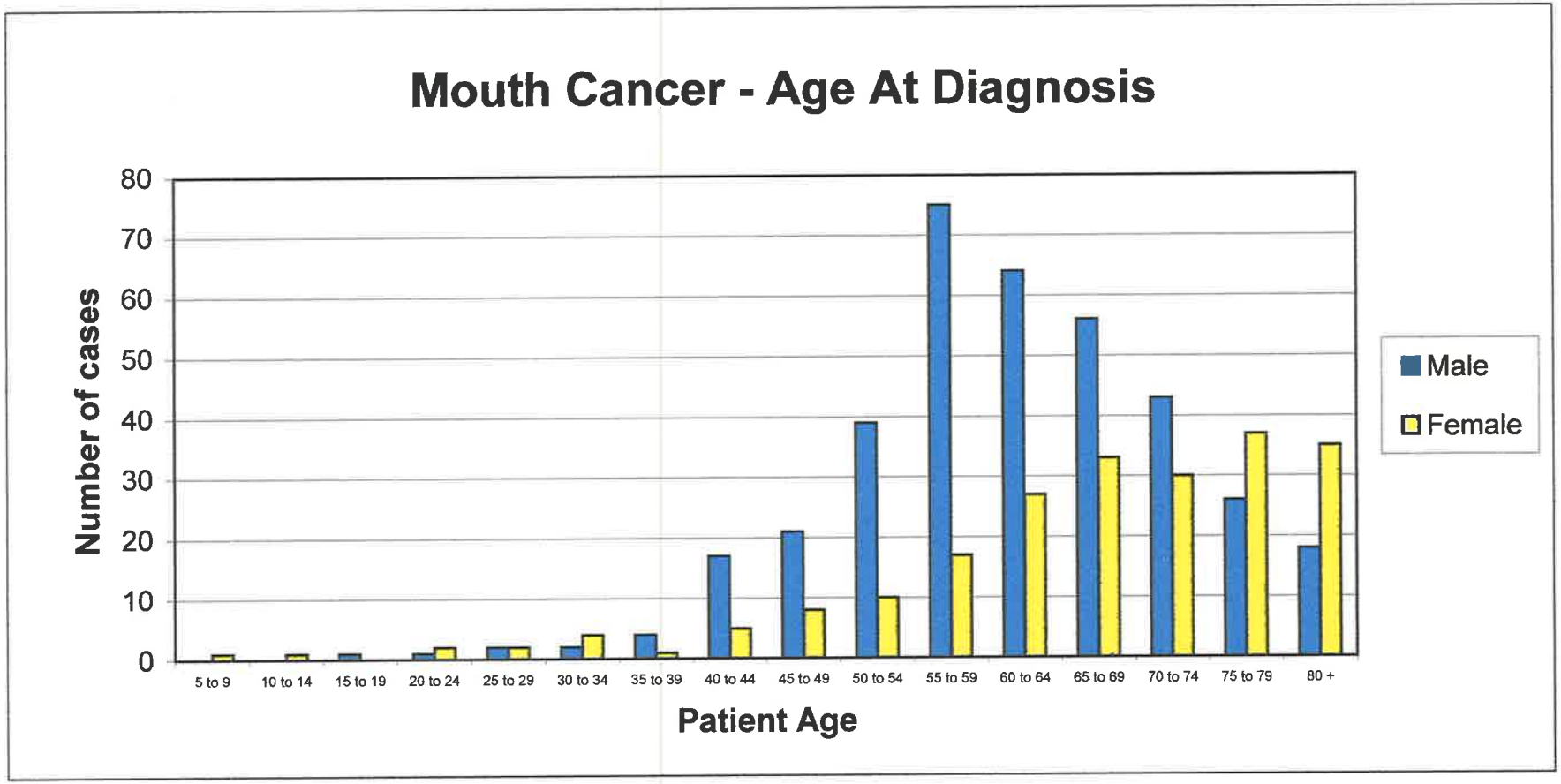

Figure 34. Mouth cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	2.51	1.87	1.86	2.00	3.05	1.82	2.41	3.43	3.11	3.05	2.31	3.00	3.24	3.07	2.89	3.18	2.48	2.60	2.73	2.72
Crude female	0.31	1.40	1.85	0.61	1.05	0.75	1.92	1.17	1.16	0.43	2.14	2.83	1.82	3.18	0.96	2.04	0.95	1.62	2.16	1.88
Standardised male	2.26	1.68	1.68	1.76	2.55	1.51	1.91	2.74	2.57	2.54	1.99	2.53	2.62	2.40	2.35	2.57	1.78	1.94	2.13	2.13
Standardised female	0.26	0.91	1.28	0.33	0.57	0.50	1.37	0.83	0.75	0.27	1.26	1.73	1.34	1.89	0.50	1.07	0.65	1.07	1.53	1.16

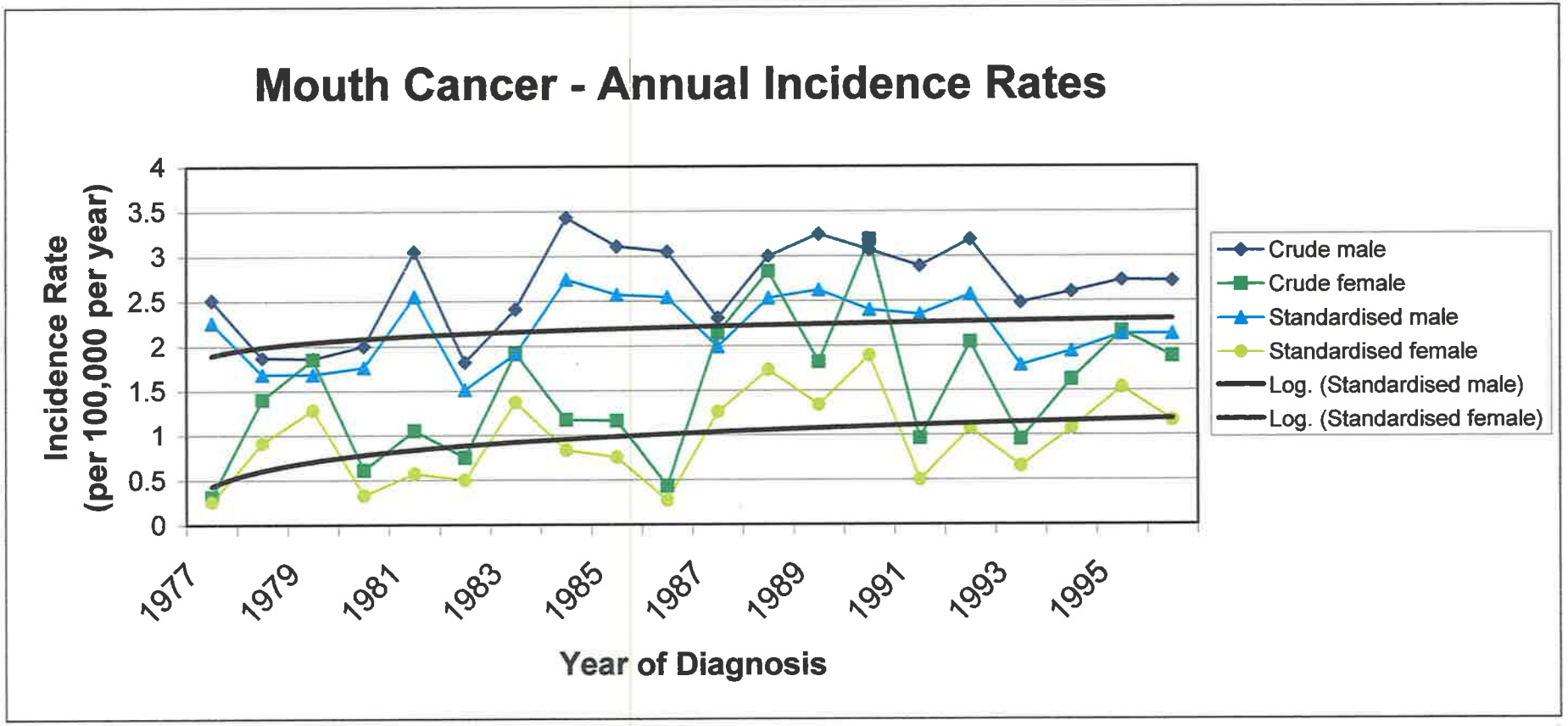

Figure 35. Mouth cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	0.78	1.25	0.62	1.23	1.22	1.06	1.50	0.75	1.19	0.73	0.86	1.00	0.85	1.26	1.65	0.97	1.52	0.96	1.09	1.09
Crude female	0.31	0.47	0.46	0.46	0.15	0.45	0.15	0.30	0.29	0.29	0.29	0.42	0.84	0.55	1.37	0.54	0.82	0.81	0.54	1.21
Standardised male	0.71	1.15	0.53	1.10	1.02	0.83	1.20	0.64	0.95	0.61	0.60	0.82	0.66	1.05	1.21	0.78	0.99	0.70	0.69	0.87
Standardised female	0.14	0.21	0.27	0.32	0.11	0.22	0.11	0.17	0.14	0.21	0.13	0.17	0.56	0.24	0.59	0.28	0.48	0.50	0.36	0.65

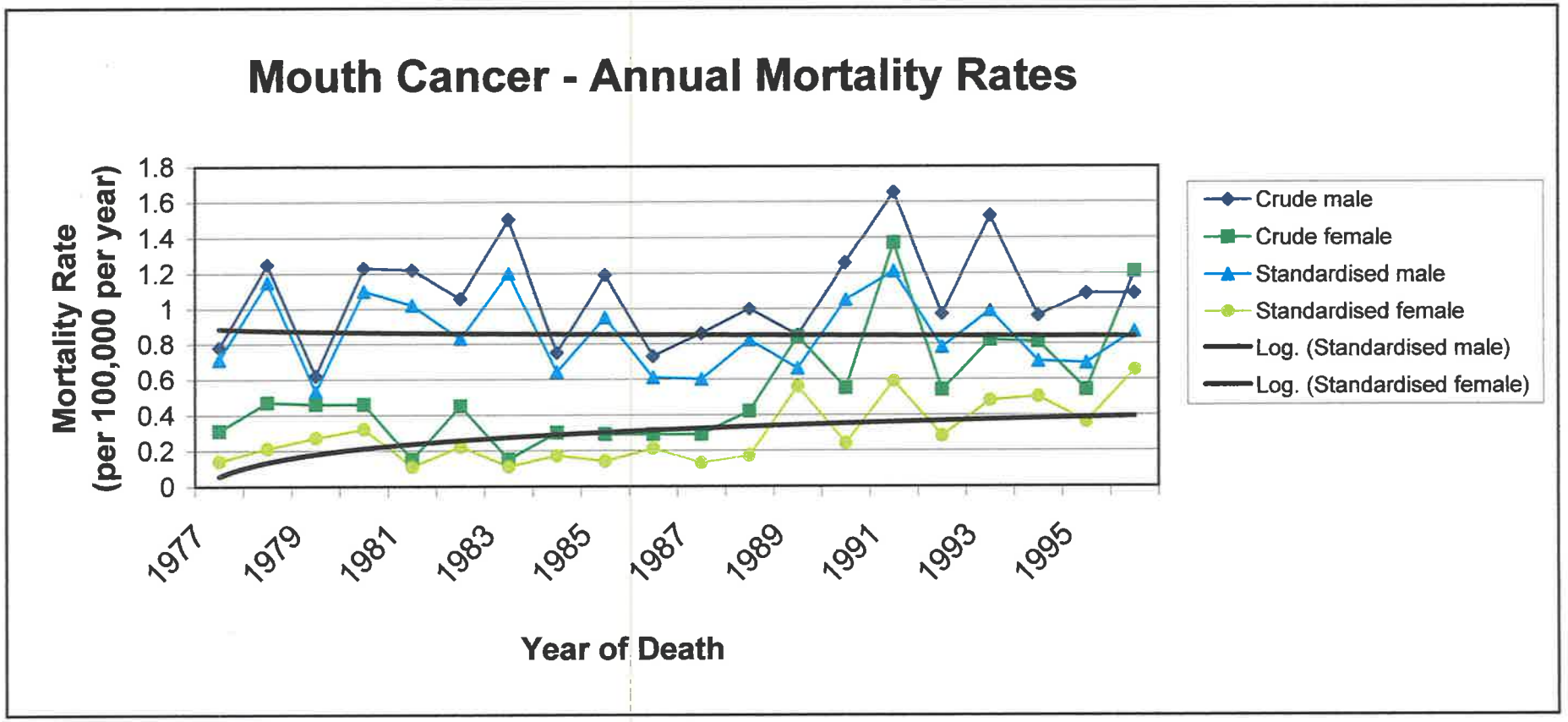

Figure 36. Mouth cancer in South Australia, 1977-1996 : Mortality trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

4.4.1 Gum, Floor of Mouth and Other Mouth Cancer

Figures 37-42 present incidence data for gum cancer (143 ICD-9), floor of mouth cancer (144 ICD-9) and other mouth cancer (145 ICD-9) respectively. Mortality data were not analysed for these sites due to the small number of cases (See Table 10).

The average age at diagnosis for gum cancer was 66.7 years in males and 73.9 years in females. The average age at diagnosis for floor of mouth cancer was 61.3 years in males and 68.7 years in females. The average age at diagnosis for other mouth cancer was 60.2 in males and 61.9 years in females. Corresponding to the data for overall mouth cancer, there were no significant trends observed in incidence rates for these sites in both males and females over the 20 year period.

	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	1	0	0	0	0	1	2	7	7	5	4	6	6	**39**
Female	0	0	0	0	1	0	0	0	2	4	8	7	9	**31**
TOTAL	1	0	0	0	1	1	2	7	9	9	12	13	15	**70**

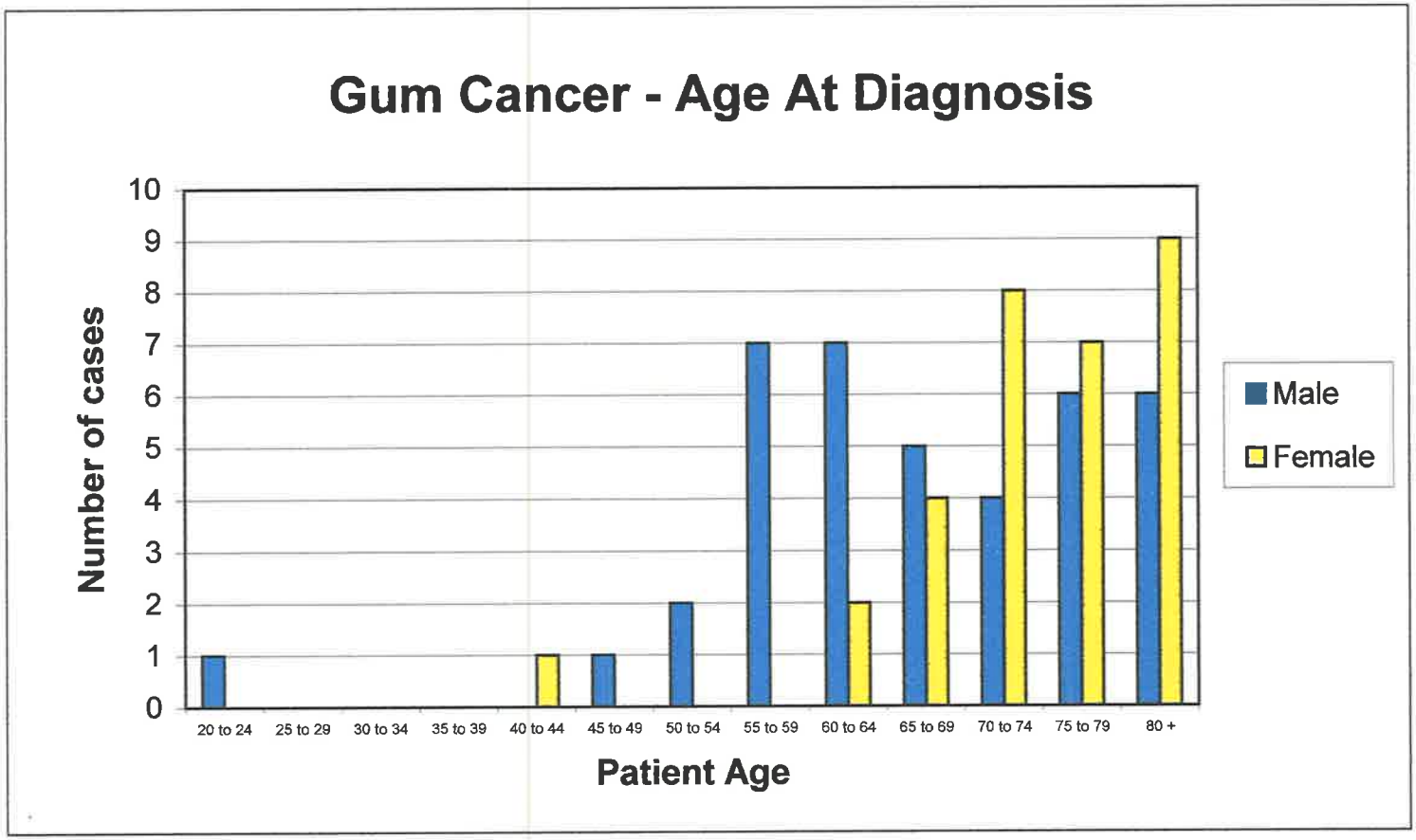

Figure 37. Gum cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	0.00	0.16	0.31	0.00	0.00	0.15	0.30	0.75	0.00	0.29	0.43	0.86	0.56	0.42	0.28	0.00	0.55	0.14	0.27	0.14
Crude female	0.00	0.31	0.15	0.31	0.15	0.30	0.15	0.44	0.29	0.00	0.14	0.14	0.28	0.55	0.14	0.68	0.14	0.14	0.00	0.13
Standardised male	0.00	0.14	0.28	0.00	0.00	0.10	0.26	0.55	0.00	0.25	0.39	0.70	0.40	0.23	0.16	0.00	0.31	0.13	0.24	0.07
Standardised female	0.00	0.14	0.06	0.14	0.06	0.15	0.06	0.29	0.16	0.00	0.08	0.12	0.20	0.22	0.05	0.31	0.07	0.09	0.00	0.07

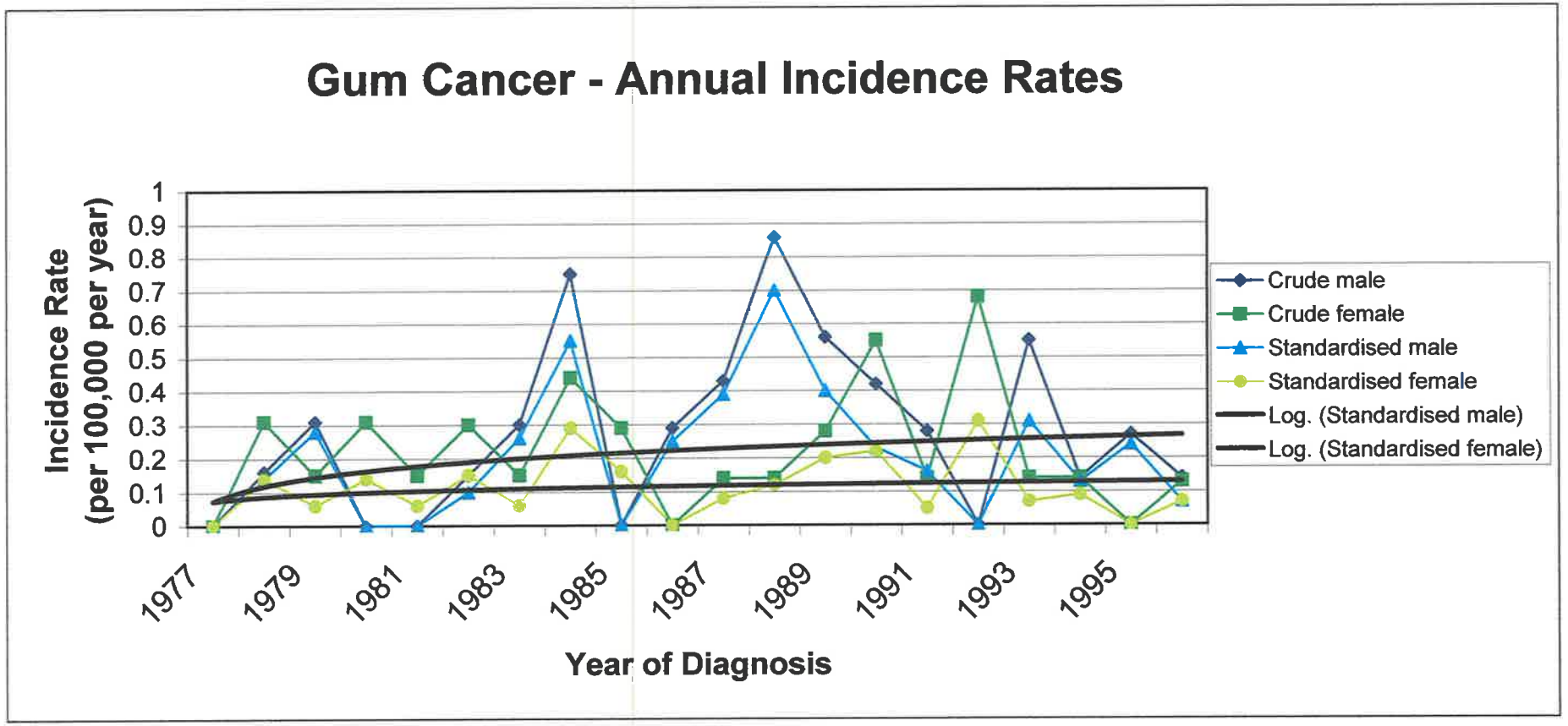

Figure 38. Gum cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data presents crude and age-standardised rates per 100,000 per annum)

	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	1	10	9	21	29	34	24	24	9	5	**166**
Female	0	1	0	4	8	8	13	7	9	10	**60**
TOTAL	1	11	9	25	37	42	37	31	18	15	**226**

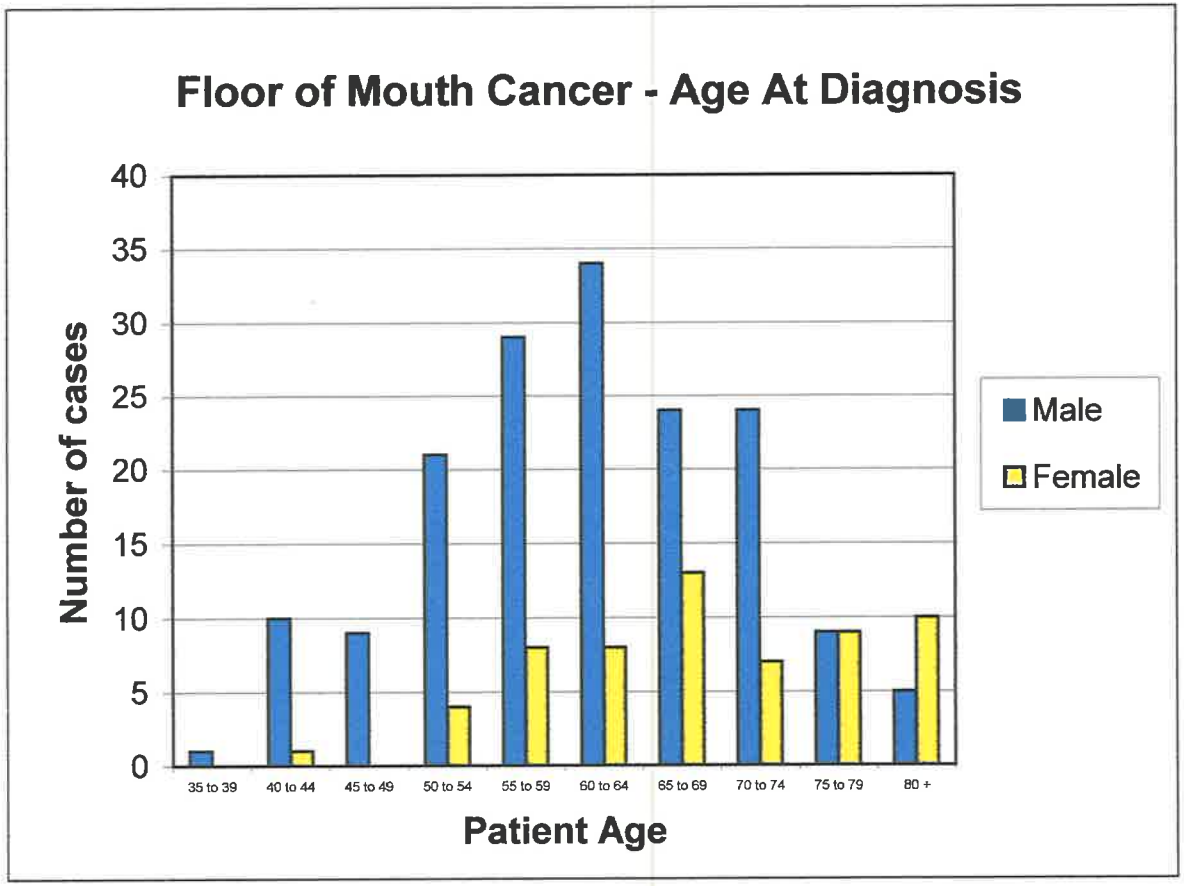

Figure 39. Floor of mouth cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	0.94	1.40	1.24	1.23	1.53	1.06	1.05	1.34	1.19	0.87	0.72	1.00	1.41	1.26	1.65	1.80	1.52	1.23	0.68	0.95
Crude female	0.16	0.62	0.92	0.15	0.45	0.00	0.59	0.29	0.15	0.00	0.57	1.13	0.28	0.69	0.27	0.68	0.14	0.54	0.40	0.54
Standardised male	0.85	1.25	1.17	1.06	1.30	0.88	0.84	1.07	0.95	0.73	0.67	0.81	1.27	1.07	1.36	1.45	1.11	0.89	0.51	0.79
Standardised female	0.08	0.52	0.63	0.11	0.24	0.00	0.41	0.22	0.11	0.00	0.34	0.71	0.21	0.50	0.13	0.37	0.05	0.31	0.27	0.26

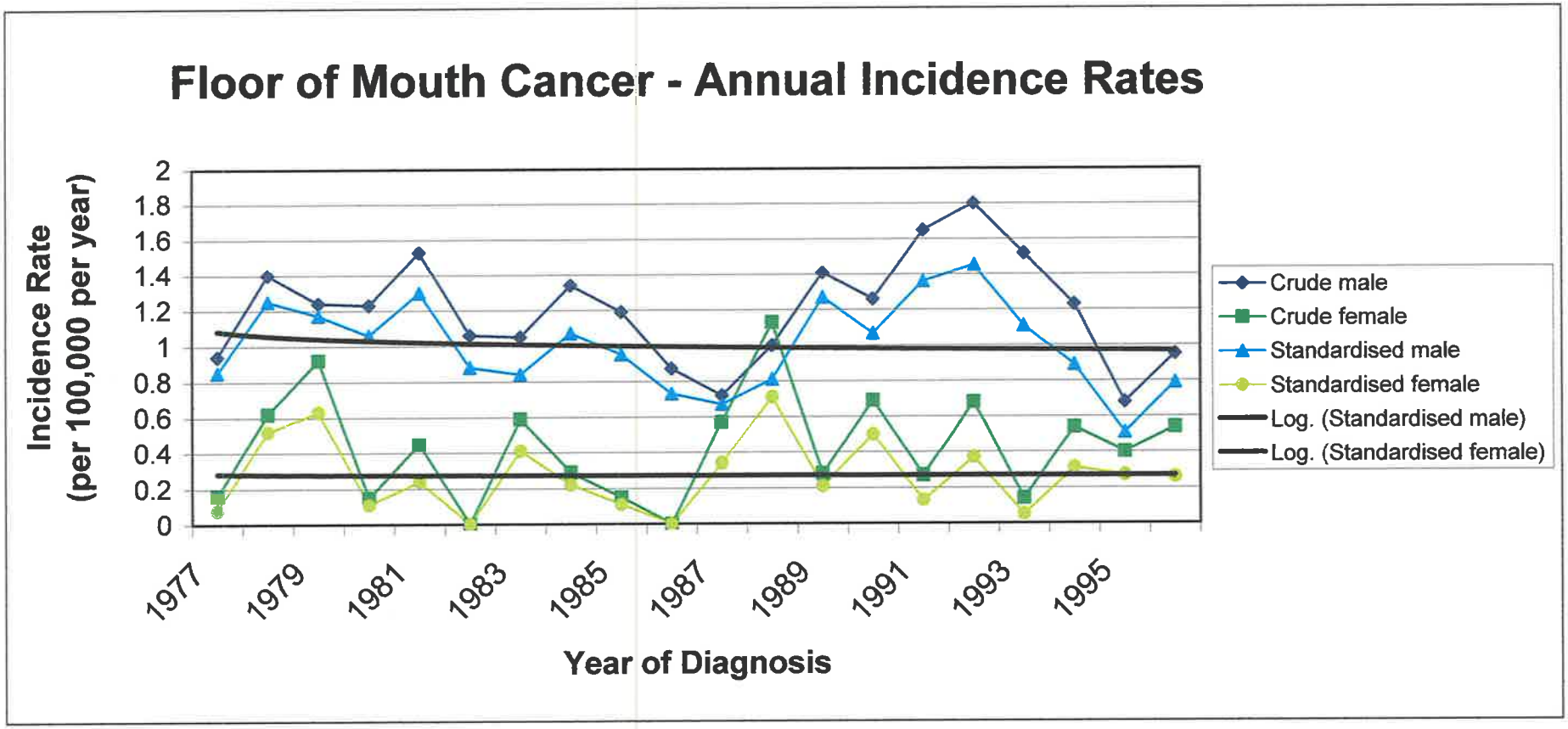

Figure 40. Floor of mouth cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data - crude and age-standardised rates per 100,000 per annum)

	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	0	0	1	0	2	2	3	7	11	16	39	23	27	15	11	7	**164**
Female	1	1	0	2	2	4	1	3	8	6	9	17	16	15	21	16	**122**
TOTAL	1	1	1	2	4	6	4	10	19	22	48	40	43	30	32	23	**286**

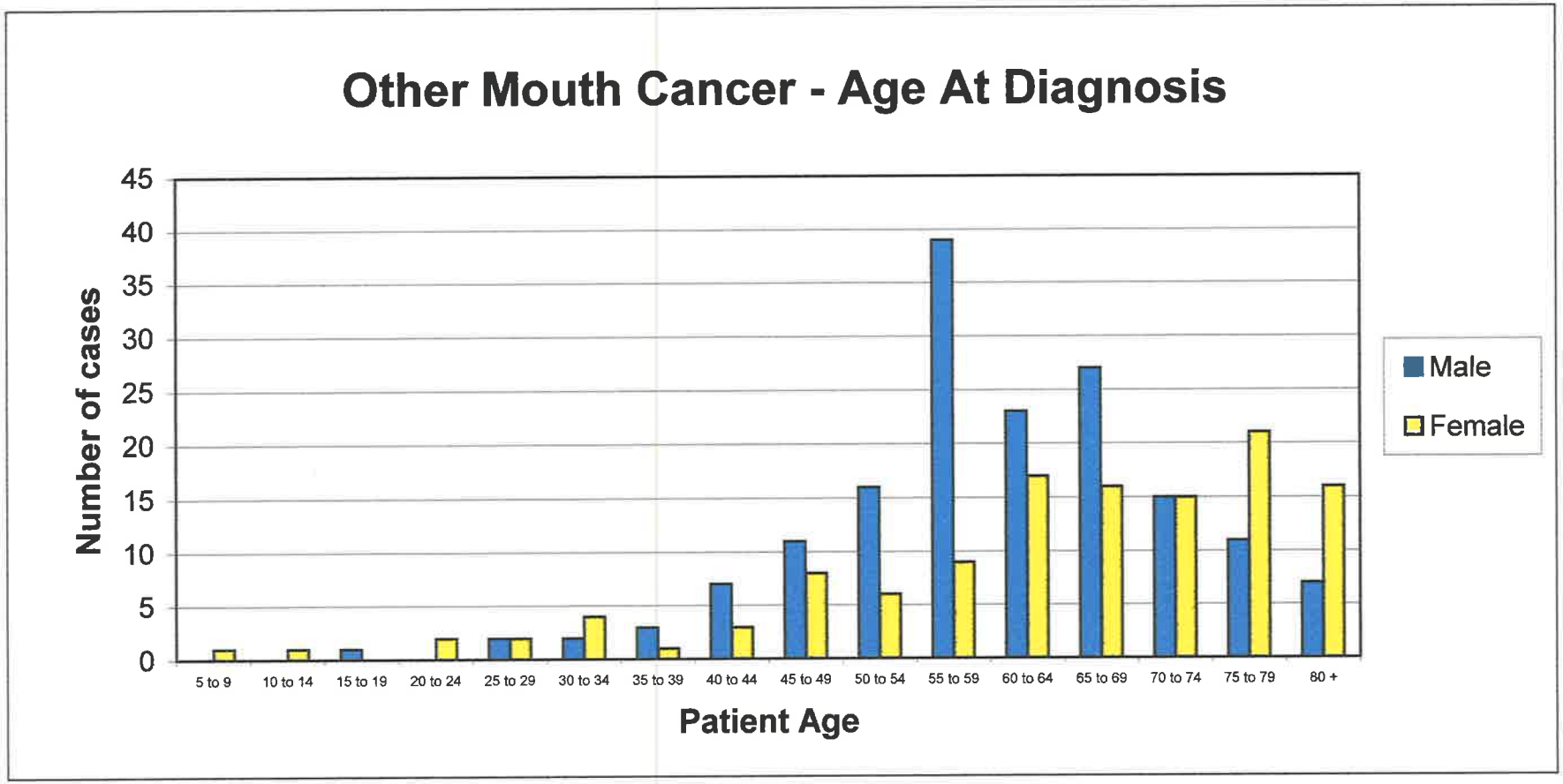

Figure 41. Other mouth cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	1.57	0.31	0.31	0.77	1.53	0.61	1.05	1.34	1.93	1.89	1.15	1.14	1.27	1.40	0.96	1.38	0.41	1.23	1.78	1.63
Crude female	0.16	0.47	0.77	0.15	0.45	0.45	1.18	0.44	0.73	0.43	1.43	1.55	1.26	1.94	0.55	0.68	0.68	0.95	1.75	1.21
Standardised male	1.41	0.29	0.23	0.70	1.26	0.54	0.81	1.11	1.62	1.57	0.94	1.01	0.96	1.10	0.83	1.12	0.35	0.91	1.37	1.26
Standardised female	0.18	0.25	0.58	0.07	0.27	0.35	0.90	0.31	0.49	0.27	0.84	0.91	0.93	1.18	0.32	0.39	0.54	0.67	1.26	0.84

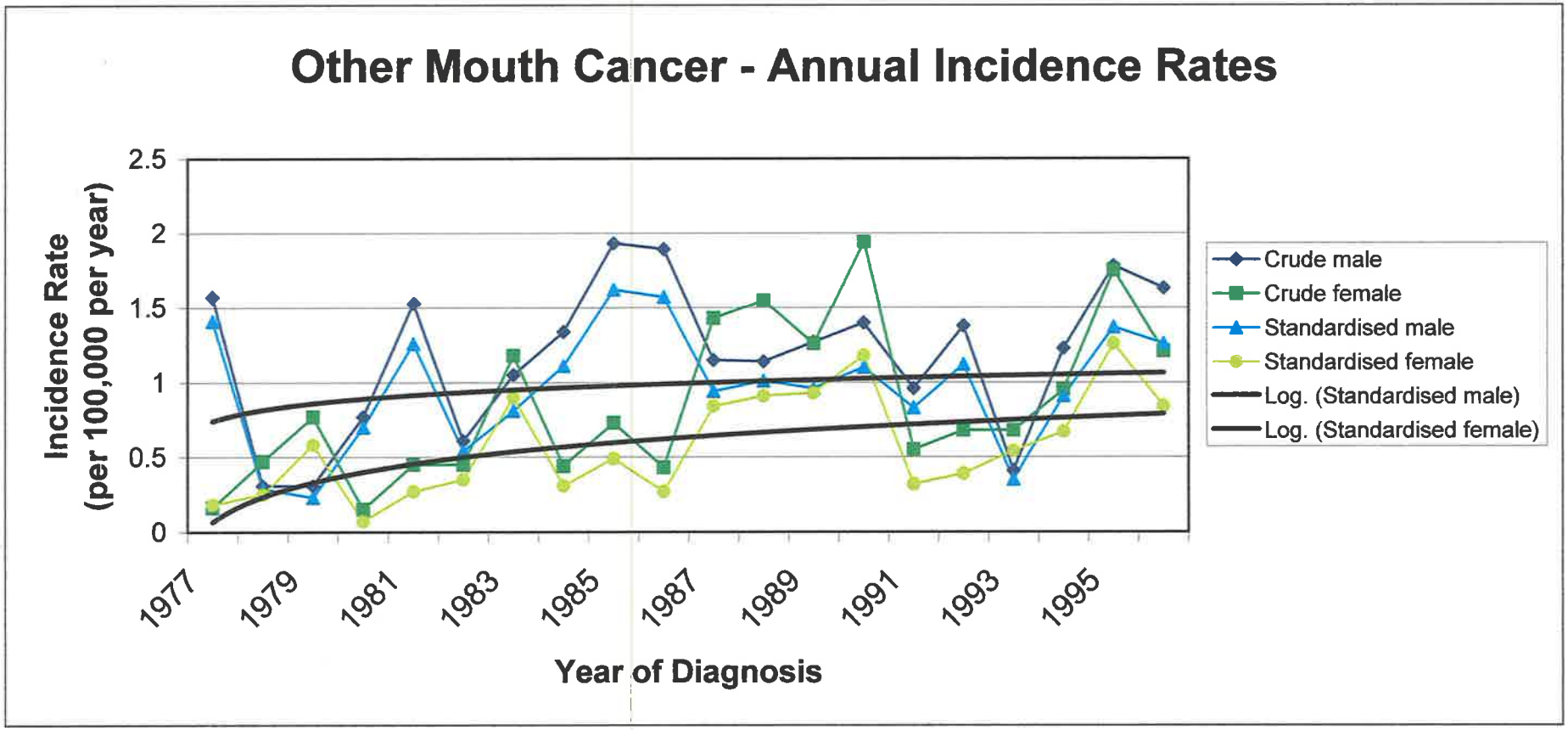

Figure 42. Other mouth cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data - crude and age-standardised data per 100,000 per annum)

4.5 Salivary Gland Cancer 142 (ICD-9)

Figures 43-45 present the data for salivary gland cancer (142 ICD-9) incidence and mortality in South Australia between 1977-1996.

Malignancies of the major salivary glands accounted for 7.4% of all oral cancers (See Table 6). The most common site for salivary gland cancer was the parotid gland (142.0 ICD-9) 78.8%, followed by the submandibular gland (142.1 ICD-9) 13.2%, unspecified gland (142.9 ICD-9) 6.0%, other major glands (overlapping sites) (142.8 ICD-9) 1.3%, and the sublingual gland (142.2 ICD-9) 0.7%. Of the various malignancies reported, mucoepidermoid carcinoma (21.5%), squamous cell carcinoma (13.9%), adenoid cystic carcinoma (10.2%), acinar/acinic cell carcinoma (10.2%), adenocarcinoma NOS (9.6%), and malignant mixed tumour (7.0%) were the main morphological types (See Table 8).

The average age of diagnosis for salivary gland cancer was 61.4 years in males and 61.9 years in females. Figure 43 shows the distribution of age at diagnosis for salivary gland cancer. Regression analysis showed highly significant association between salivary gland cancer incidence and increasing patient age for both sexes ($P<0.0001$).

The crude and age-standardised incidence rates for salivary gland cancer in South Australia between 1977-1996 are presented as Figure 44. The rate for males remained stable over the 20 year period ($P=0.1931$). The female rate did not change significantly between 1977-1996 ($P=0.4869$). Mortality rates for salivary gland cancer in South Australia between 1977-1996 are presented as Figure 45. There were no significant trends in the mortality rates in either sex over the 20 year period.

	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 +	TOTAL
Male	0	0	2	6	11	3	10	10	15	24	18	20	28	21	22	**190**
Female	3	2	1	3	2	4	7	6	6	5	15	17	11	7	23	**112**
TOTAL	3	2	3	9	13	7	17	16	21	29	33	37	39	28	45	**302**

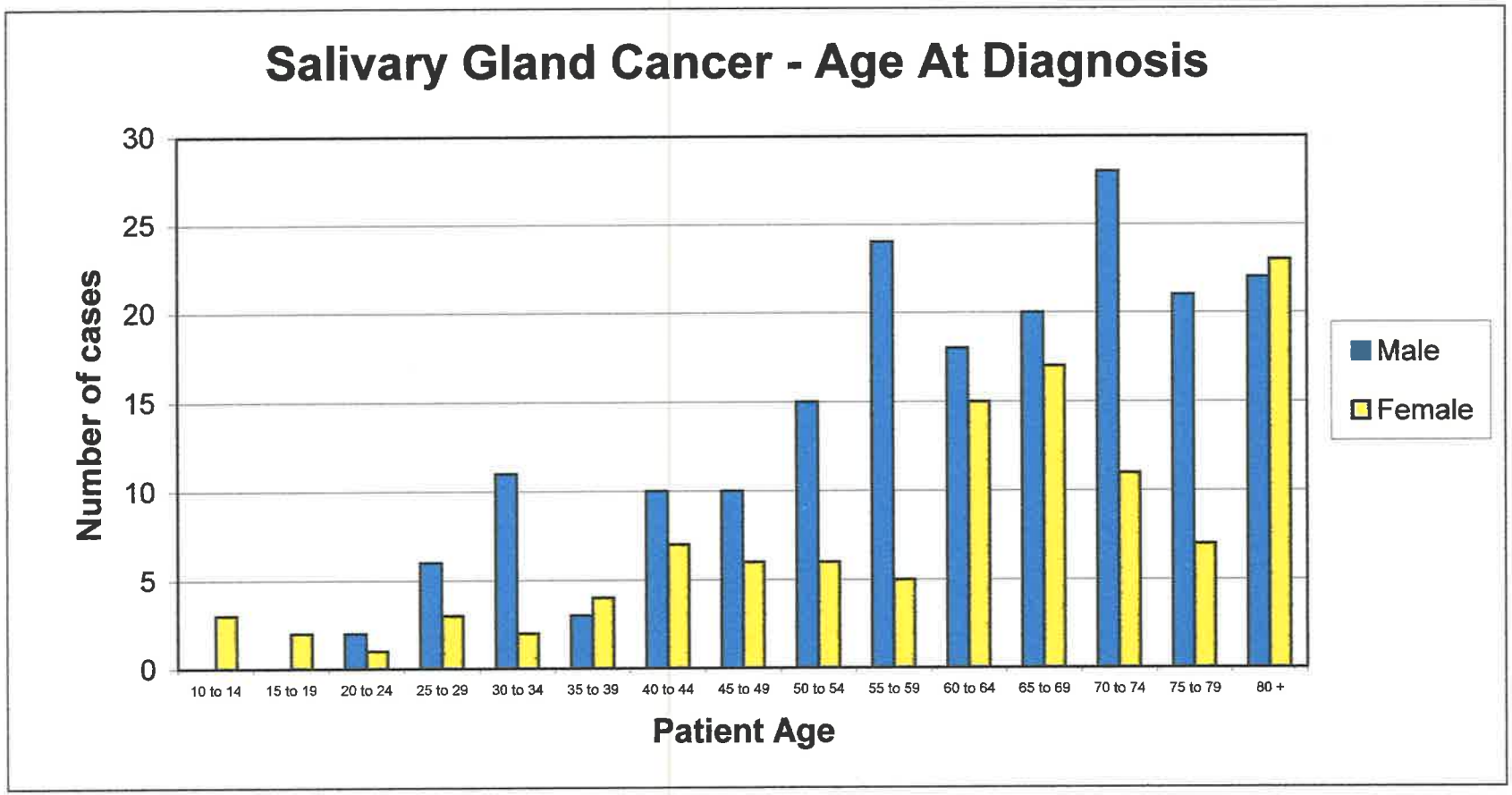

Figure 43. Salivary gland cancer in South Australia, 1977-1996 : Age at diagnosis (Tabulated data shows actual number of cases).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	1.10	0.93	2.33	1.54	1.83	1.97	1.20	1.64	1.19	1.16	1.44	0.57	1.27	0.42	0.69	1.66	1.52	1.78	1.91	1.50
Crude female	0.63	0.78	0.77	0.77	0.90	0.60	1.33	0.44	0.58	0.29	1.14	0.85	0.84	0.42	0.68	1.09	0.95	0.81	1.21	0.94
Standardised male	0.99	0.85	2.01	1.30	1.45	1.62	1.02	1.36	0.98	0.85	1.08	0.47	0.99	0.34	0.52	1.18	1.04	1.39	1.38	0.91
Standardised female	0.59	0.62	0.45	0.74	0.64	0.47	1.07	0.33	0.41	0.18	0.78	0.62	0.69	0.24	0.63	0.70	0.61	0.63	0.63	0.41

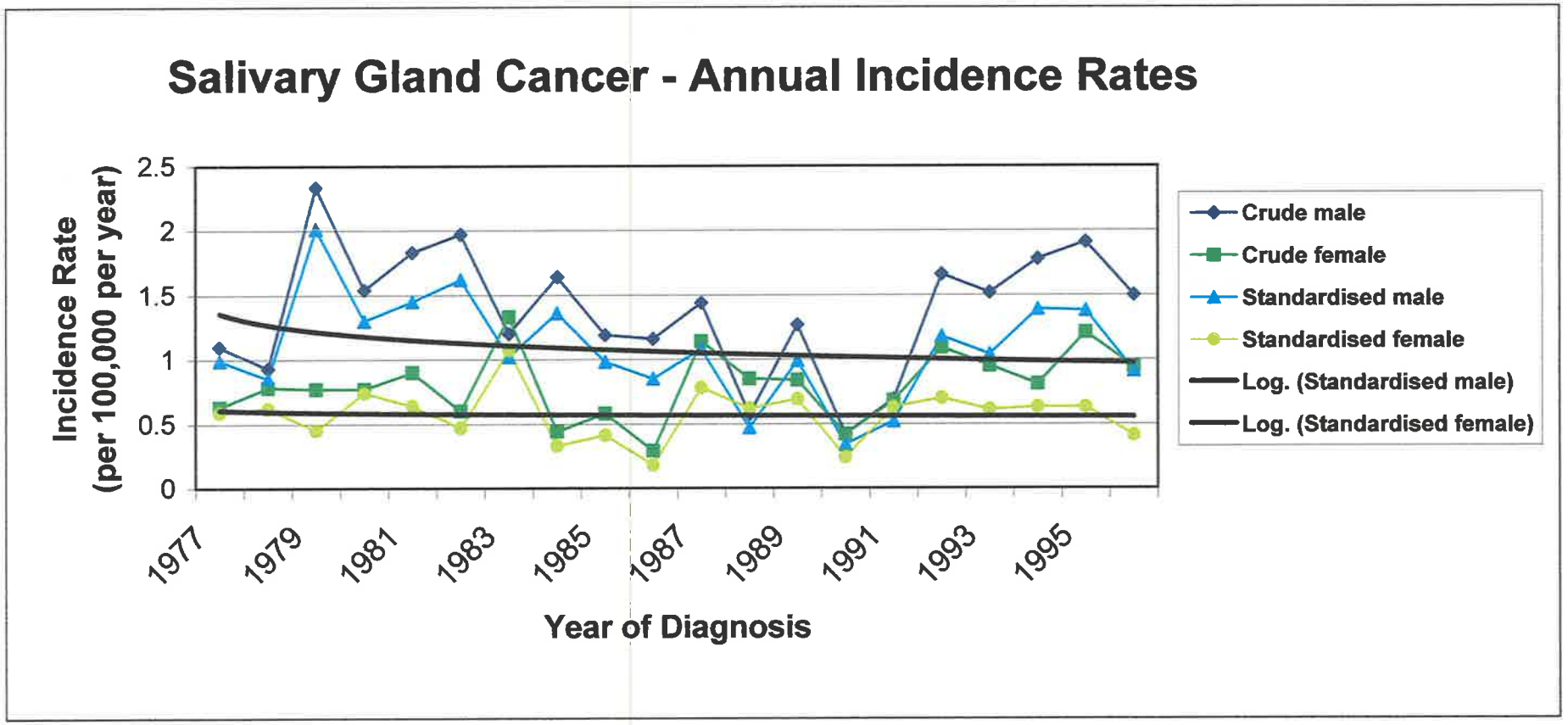

Figure 44. Salivary gland cancer in South Australia, 1977-1996 : Incidence trends (Tabulated data - crude and age-standardised rates per 100,000 per annum)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Crude male	0.31	0.47	0.93	0.62	0.61	0.76	1.35	0.60	0.59	0.44	0.43	0.43	0.00	0.14	0.28	0.41	0.69	0.55	0.82	0.95
Crude female	0.16	0.47	0.15	0.00	0.15	0.45	0.30	0.00	0.15	0.58	0.00	0.14	0.14	0.14	0.14	0.00	0.41	0.14	0.27	0.13
Standardised male	0.00	0.27	0.55	0.46	0.49	0.37	1.10	0.39	0.47	0.38	0.29	0.33	0.00	0.08	0.22	0.25	0.50	0.29	0.58	0.67
Standardised female	0.14	0.37	0.07	0.00	0.06	0.30	0.21	0.00	0.17	0.33	0.00	0.04	0.12	0.04	0.04	0.00	0.20	0.04	0.17	0.03

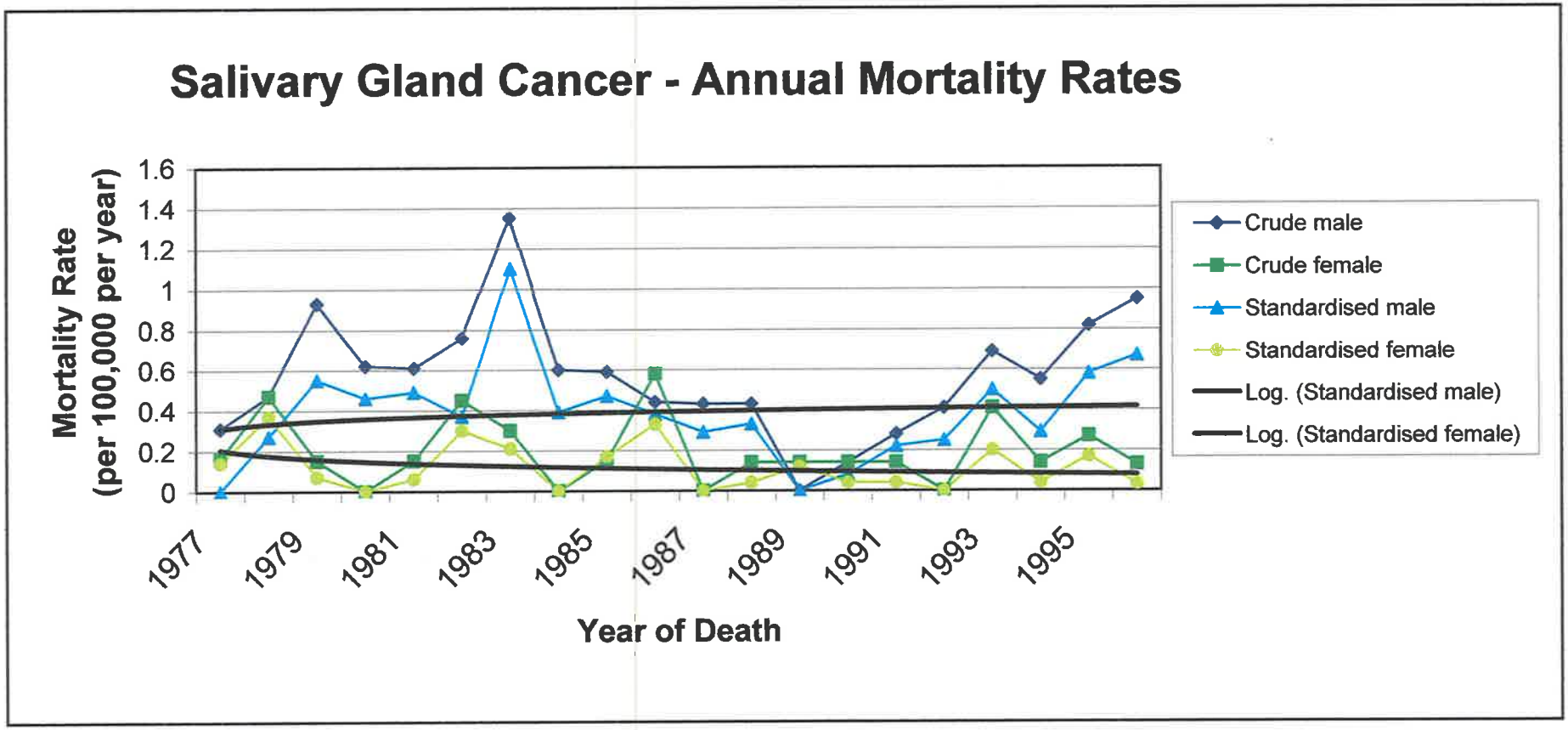

Figure 45. Salivary gland cancer in South Australia, 1977-1996 : Mortality trends (Tabulated data - crude and age-standardised rates per 100,000 per annum)

Chapter Five

Discussion

5.1 Introduction

Oral cancer is a disease involving the tissues of the lips and oral cavity. The patterns of global epidemiology are far from uniform and the trends in oral cancer in South Australia over the past 20 years are also quite unique.

A number of researchers (Boyle *et al* 1990, Jovanovic *et al* 1993a, Morse *et al* 1998, Sankaranarayanan 1990a, Smith 1979) have highlighted the terminology dilemma concerning "oral cancer". There is no standardised terminology or definition for oral cancer in the literature and there are even instances where the same author has used a different term or definition in different papers (See Table 2). As a consequence, comparisons of individual studies must be carried out with some degree of caution. The revised coding system in the 10th edition of the *International Classification of Diseases* (ICD-10) (WHO 1992), attempts to address this problem, but it appears that most researchers are not willing to apply this system in their publications. For example, the latest edition of *Cancer Incidence in Five Continents* (Parkin *et al* 1997) still uses the coding from the 9th Edition *International Classification of Diseases* (ICD-9) (WHO 1977). Reviewing both the global incidence and mortality trends and the situation in South Australia over the past 20 years, a reasonable classification for "oral cancer" may be to group it into the following subgroups:

Lip - 140 (ICD-9); C00 (ICD-10)

Intraoral or Buccal cavity - 141, 143-145 (ICD-9); C01-C06 (ICD-10)

Salivary Glands - 142 (ICD-9); C07-C08 (ICD-10).

The cancers in these broader groups seem to have similar biological and epidemiological characteristics. It is felt that the term "intraoral cancer" is a better description than "mouth cancer", which usually refers to intraoral sites excluding the tongue. Although some authors have suggested this or a similar classification (Chen *et al* 1992; Johnson and Warnakulasuriya 1993; Moreno Lopez and Esparza Gomez 1998; Morse *et al* 1999), the vast majority of studies continue to group oral and pharyngeal cancers together. While combining all sites may decrease the problems of mapping large lesions and identifying a primary site in overlapping lesions, as well as increasing the number of cases for study in the broader diagnostic category, it does result in the loss of much information of cancers in the individual sites (Smith 1989; , Muir and Staszewski 1991; Oreggia 1991; Chen *et al* 1992; Morse *et al* 1999). This is clearly demonstrated in the South Australian data where lip cancer is the dominant form of "oral cancer".

In this study, it was decided to use the existing coding system of the South Australian Cancer Registry (i.e. ICD-9), rather than attempting to update the data to the later coding (i.e. ICD-10). It is recognised that this may only serve to propagate the problem, but particular emphasis is given to the trends in individual sites rather than to "oral cancer" as a whole.

5.2 Oral Cancer 140-5 (ICD-9)

The trends in incidence and mortality for oral cancer (140-5 ICD-9) over the period 1977-1996 are interesting. The fact that squamous cell carcinoma is the dominant histological type (See Table 7) conforms to well established worldwide trends (Smith 1979, Walton *et al* 1991; Daftary *et al* 1992; Muir and Weiland 1995). The general global trend that it occurs more commonly in males and increases with age (Pindborg 1977; Smith 1989; Johnson 1991; Chen *et al* 1992; Daftary *et al* 1992; Johnson & Warnakulasuriya 1993) are also clearly evident in the South Australian data (Figures 21 and 22). What is of interest, however, is the dominance of lip cancer in South Australian oral cancer for both males and females. This high incidence of lip cancer in South Australia completely obscures the fact that intraoral and salivary gland cancer incidence are quite low. An inverse relationship between the incidence of extraoral (i.e. lip) and intraoral forms of oral cancer is clearly demonstrated by the South Australian data. Figures 23 and 24 show how the age-standardised oral cancer incidence rate basically follows the lip cancer trend in both males and females. The male/female incidence ratio fell from 4.47 between 1977-1981 to 2.98 between 1992-1996 (See Table 9). Once again this principally reflects a fall in the corresponding lip cancer ratios over the 20 year period. This finding provides further strong evidence for the importance of separating the lip from other intraoral cancer sites in any oral cancer studies (Chen *et al* 1992, Morse *et al* 1999).

The mortality rates for oral cancer in South Australia are less dramatic. It is well recognised that lip cancer has a high survival rate (Antoniades *et al* 1995, Gerson 1990, Muir & Weiland 1995), and this means that although incidence rates are high, the mortality from oral cancer in South Australia between 1977-1996 was quite low

and stable (Figures 25-27). This contrasts to reports from a number of European countries, particularly Eastern Europe (Hill *et al* 1991; La Vecchia *et al* 1992; Macfarlane *et al* 1994a, Plesko *et al* 1994; La Vecchia *et al* 1997) and Japan (Su *et al* 1999, Zheng *et al* 1999), where mortality rates from oral cancer are increasing, particularly amongst males.

5.3 Lip Cancer 140 (ICD-9)

The incidence of lip cancer (140 ICD-9) in South Australia over the period 1977-1996 is the most significant and puzzling finding of this study. As previously discussed, cancer of the lip dominates all other oral cancer sites in South Australia. One important point about the South Australian lip cancer data, however, is that it includes lesions reported on the skin of the lip (173.0 ICD-9). This practice, which has occurred since the establishment of the South Australian Cancer Registry, was apparently instituted in order to eliminate a potential problem of under-reporting of lip cancer cases. It is believed that malignancies that begin on the vermilion but spread to the dermis may be incorrectly classified as skin cancer and therefore not included in the oral cancer data (See Appendix I). It must be pointed out, however, that this subsite accounts for 8.4% of all cases of lip cancer reported between 1977-1996, which tends to elevate the South Australian figures, compared to other registries that do not include this subsite. Perhaps the definition of Ebenius from 1943 should not be forgotten : "No other cancer than that arising in the red of the lip should be regarded as genuine lip cancer" (Morton *et al* 1983).

It is well recognised that the lower lip is by far the most common site for lip cancer (Chen *et al* 1992; Daftary *et al* 1992; Antoniades *et al* 1995; Ostman *et al* 1995; Faye-Lund & Abdelnoor 1996; de Visscher *et al* 1998; Morse *et al* 1999). This trend is supported by the South Australian data (See Table 6), with almost 75% of lesions occurring at this site. This observation, combined with the fact that lip cancer tends to occur far more commonly in men employed in outdoor activities (i.e. fishermen, farmers and labourers), has led to the suggestion that sunlight is the key aetiologic agent in its pathogenesis (Lindqvist & Teppo 1978; Lindqvist *et al* 1981; Douglass &

Gammon 1984; Brownson *et al* 1989; Pukkala *et al* 1994; Antoniades *et al* 1995; Pukkala and Notkola 1997; Acquavella *et al* 1998). The South Australian data provided no information about patient's occupation, so this trend could not be confirmed.

Many researchers have observed that lip cancer occurs more commonly in elderly males (Chen *et al* 1992; Abdelnoor *et al* 1995; Ostman *et al* 1995; de Visscher *et al* 1998; Morse *et al* 1999). The South Australian data supports this trend with 77.1% of cases seen in males and the average age at diagnosis being 58.3 years (Figure 28). In females, the average age at diagnosis was 66.0 years. A highly significant association between lip cancer incidence and increasing age was found in both sexes. It is interesting to note, however, that when cancer of the upper lip (140.0 ICD-9) is analysed separately, the gender discrepancy almost disappears (Males 108 cases, Females 102 cases). As a consequence, while upper lip accounts for only 5.2% of lip cancer cases in males, it comprises 16.4% of lip cancers in females. This trend has been noted in other regions including Connecticut (Chen *et al* 1992; Morse *et al* 1999), the Netherlands (de Visscher *et al* 1998), and Sweden (Ostman *et al* 1995). Almost 20 years ago, Lindqvist and Teppo (1980) proposed that upper lip cancer should be considered as a completely distinct type of cancer separate to other lip sites, and the distinctive epidemiology of this lip cancer subsite in South Australia might add further support to this suggestion.

It has been noted that lip cancer is relatively rare in dark skinned populations (Lindqvist 1979; Onuigbo 1978; Binnie & Rankin 1988b; Parkin *et al* 1992; Parkin *et al* 1997; de Visscher & van der Waal 1998), a trend that has been explained by the

protective effects of natural skin pigments against the carcinogenic action of solar radiation (Douglas & Gammon 1984). Unfortunately no data were available for lip cancer incidence in South Australian Aborigines, to allow a similar analysis in this state between 1977-1996.

The overall incidence rates for lip cancer in South Australia between 1977-1996 are particularly significant (Figure 29). Both male and female rates are amongst the highest in the world and, contrary to general global trends, they have increased significantly in the 20-year period. While the male rate seems to have plateaued in the past decade, it remains high not only in the Oceania region, but also when considering other regions known for higher incidence of lip cancer including the Maritime Provinces of Canada and parts of Europe, particularly Spain. No current data was available from Queensland, which had previously reported higher rates of lip cancer than South Australia (Tan 1970; Muir *et al* 1987).

The female incidence rate is of particular concern. Not only is it the highest reported rate for any country in the world (Parkin *et al* 1997), but contrary to global trends (Coleman *et al* 1993; Macfarlane *et al* 1993; Devesa *et al* 1995; de Visscher *et al* 1999; Morse *et al* 1999), it continues to increase at an alarming rate. Ostman *et al* (1995) noted a slight increase in the incidence of lip cancer in females in the Netherlands between 1960-1989, but this is not nearly as dramatic as the South Australian trend. More recent data for lip cancer in South Australian females maintains this high level with an incidence rate of 4.3 per 100,000 per annum being reported during 1997 (South Australian Cancer Registry 1998) and 5.1 per 100,000 per annum in 1998 (South Australian Cancer Registry 1999). This change is also

reflected in the male/female incidence ratio for lip cancer which has fallen from 5.32 between 1977-1981 to 3.42 between 1992-1996 (See Table 9). The reason for the surprisingly high incidence of lip cancer in South Australian females is unclear. Whether females are being exposed to more of the commonly cited risk factors (i.e. sunlight, tobacco smoking, and viruses) can only be surmised from this data, but the fact that lip cancer continues to increase at an alarming rate in South Australian females remains a major cause of concern.

It is well known that the slow growth rate of lip cancers, the rarity of lymph node metastases, and the accessibility of the site for complete surgical excision, results in a low mortality rate (Gerson 1990; Antoniades *et al* 1995; Muir & Weiland 1995). This is confirmed in the South Australian data between 1977-1996, with only 35 reported deaths from lip cancer in the 20-year period (See Table 10). Hence, age-standardised mortality rates never exceeded 0.5 per 100,000 per annum in either sex (See Figure 30) and for a number of the years, this rate was zero.

5.3 Tongue Cancer 141 (ICD-9)

Many researchers have found that the tongue (141 ICD-9) is the most common intraoral site for cancer (Krolls & Hoffman 1976; Mashberg, 1989; Chen *et al* 1990b; Hamada *et al* 1991; Hindle & Nally 1991). The South Australian data confirms this finding with the tongue accounting for 45.0% of intraoral cancers in males and 41.6% in females. The observation that squamous cell carcinoma was the predominant histopathological type of lingual malignancy in South Australia, follows the pattern seen in other regions (Chen *et al* 1991; Muir & Weiland 1995; Ramirez-Amador *et al* 1995). It is interesting to note that almost 10% of lingual cancers were lymphoepithelial. Tongue cancer is a disease of the elderly and the South Australian data supports this trend with the average age at diagnosis being 62.2 years in males and 65.5.years in females. There was also a highly significant association between tongue cancer incidence and increasing patient age in both sexes. Nevertheless, there were a few cases of tongue cancer (1.3%) in patients aged less than 30 years of age.

In comparison to other parts of the world, the incidence of tongue cancer in South Australians was low, with the age-standardised male rate never exceeding 2.5 per 100,000 per annum and the female rate rarely rising above 1.0 per 100,000 per annum. The male/female incidence ratio has risen between 1977-1996 (See Table 9), but it is important to note that there was no significant change in the incidence rates in either sex over the 20-year period. This contrasts to findings elsewhere in the world including parts of the United States (Davis & Severson 1987; Coleman 1993), England and Wales (Hindle & Nally 1991), Scotland (Macfarlane *et al* 1992), Denmark (Moller 1989), Finland (Kari *et al* 1997), Sweden (Ostman *et al* 1995), and Japan (Coleman *et al* 1993). Although the incidence of tongue cancer remains high in

many parts of the Indian subcontinent, the overall risk has been described as stable or falling (Coleman *et al* 1993). A study by Macfarlane *et al* (1994b) found that the incidence of tongue cancer in males in New South Wales rose between 1972-1990, while Cox *et al* (1995) found a similar trend in both males and females in New Zealand from 1955-1991.

Tongue cancer accounted for almost 200 deaths in South Australia over the 20-year period, i.e. 35.0% of all oral cancer deaths and 46.7% of intraoral cancer deaths (See Table 10). The age-standardised mortality rates were low with the male rate rarely exceeding 1.0 per 100,000 per annum and the female rate staying below 0.3 per 100,000 per annum for all but one year. These mortality rates remained stable over the 20-year period in both sexes. This contrasts with the increasing mortality from tongue cancer reported for parts of the United States (Depue 1986) and Europe (Macfarlane *et al* 1987; Coleman *et al* 1993), particularly France (Hill *et al* 1991).

5.5 Mouth Cancer 143-5 (ICD-9)

Mouth cancer (143-5 ICD-9) (i.e. cancer of the gum, floor of mouth and other mouth) accounted for 14.4% of oral cancer in South Australia between 1977-1996. Following well reported global trends (Chen *et al* 1990b; Daftary *et al* 1992; Muir & Weiland 1995; Ostman *et al* 1995), squamous cell carcinoma was the dominant form of malignancy in this location (77.7%), although other types of neoplasms including lymphoepithelial carcinoma (8.1%), and various salivary gland malignancies, also contributed significant numbers of cases (See Table 8). The classification of malignancies of the minor salivary glands according to site has occurred since the ninth revision of *The International Classification of Diseases* (WHO 1977). As they only contribute a small number of cases to a site dominated by squamous cell carcinoma, this combination tends to mask the distinctive epidemiology of minor salivary gland tumours, a point made strongly over 20 years ago by Pindborg (1977).

Paralleling trends seen in tongue cancer, the other forms of intraoral cancer occurred more frequently in elderly patients with the average age at diagnosis being 61.4 years in males and 66.7 years in females. This is confirmed by the highly significant statistical association between mouth cancer incidence and increasing patient age in both sexes. It is interesting to note that a small number of cases of mouth cancer (1.7%) were reported in patients under 30 years of age. While not providing a statistically significant trend, the observation of intraoral cancers (tongue and mouth) occurring in young patients, especially females (10 out of 16 cases), must be monitored.

In comparison to other parts of the world, the incidence of mouth cancer in South Australia between 1977-1996 was low, with the age-standardised male rate rarely exceeding 2.5 per 100,000 per annum and the female rate rarely rising above 1.5 per 100,000 per annum. Over the 20-year period the male/female incidence ratio for mouth cancer fell from 2.96 between 1977-1981 to 1.93 between 1992-1996. This contrasts with an increasing sex ratio for tongue cancer over the same period (See Table 9). As with tongue cancer, however, there was no significant change in the incidence rates of the other forms of intraoral cancer in either sex over the 20-year period. This contrasts to findings elsewhere in the world including parts of the United States (Chen *et al* 1990; Morse *et al* 1999), England and Wales (Hindle *et al* 1996), Scotland (Macfarlane *et al* 1992), Denmark (Moller 1989), Sweden (Ostman *et al* 1995), Hungary (Coleman *et al* 1993), and Japan (Coleman *et al* 1993). Like tongue cancer, the incidence of mouth cancer remains high in many parts of the Indian subcontinent, although the overall risk has been described as stable or falling (Coleman *et al* 1993). Gupta and Nandakumar (1999) reported that, since 1982, the incidence rates for cancer of the oral cavity (all sites) have not shown any significant change in either sex in any of the Indian population-based cancer registries. These researchers suggest that "although traditional forms of tobacco chewing habits appear to have decreased, they have perhaps only been replaced by smoking and have not affected incidence rates of oral cancer". A study by Cox *et al* (1995) found that mouth cancer incidence rose risen significantly in both males and females in New Zealand between 1955-1991.

Mouth cancer accounted for 226 deaths over the 20-year period i.e. 40.0% of all oral cancer deaths and 53.3% of intraoral cancer deaths (See Table 10). The age-

standardised mortality rates were low, with the male rate rarely exceeding 1.0 per 100,000 per annum and the female rate staying below 0.5 per 100,000 per annum for all but two years. Importantly, these mortality rates remained stable over the 20-year period in both sexes. This contrasts with the increasing mortality from mouth cancer reported for France (Hill *et al* 1991), England (Hindle *et al* 1996), Japan (Zheng *et al* 1999; Su *et al* 1999), and New Zealand (Cox *et al* 1995).

Looking at individual sites of mouth cancer, the floor of mouth is an important site for intraoral cancer with 5.6% of all oral cancers and 21.8% of intraoral cancers occurring at this site. This finding provides further support for the previously discussed Lederman's hypothesis (Mashberg *et al* 1989) which proposes that the pooling of carcinogens in saliva in oral food channels or "gutter zones" (Johnson & Warnakulasuriya 1993) increases the risk of oral cancer developing at these sites. The number of deaths from gum cancer is another interesting finding. Although mortality rates were not carried out for these sites due to the small number of cases reported, the 37 deaths from gum cancer appears high considering only 70 new cases of malignancy were reported at this site in the 20-year period. Using the D/R ratio (Binnie 1976; Hindle & Nally 1991) as a crude measure of survival over the 20-year period, gum cancer has a ratio of 0.53:1 compared to tongue cancer 0.44:1, mouth cancer 0.39:1 and lip cancer 0.01:1. The reason gum cancer in South Australia was so lethal between 1977-1996 is not known, but the data should be further investigated using the more accurate measure of 5-year survival rates.

5.6 Salivary Gland Cancer 142 (ICD-9)

The unique epidemiology and histopathology of salivary gland neoplasms provides strong evidence that they should be considered as a distinct cancer site, separate from other forms of oral cancer, i.e. lip and intraoral. This proposal is strongly supported by the findings in South Australia between 1977-1996.

The general trends in terms of site of occurrence of salivary gland malignancies followed expected trends, with the vast majority (almost 80%) occurring in the parotid gland. The next most common site was the submandibular gland (13.2%) with the remaining cases occurring in unspecified gland (6.0%), overlapping sites (1.3%) and the sublingual gland (0.7%). While a specific analysis was not carried out of salivary gland malignancies in the minor glands, Table 8 indicates that these neoplasms were reported elsewhere in the mouth. The histopathology of salivary gland cancer in South Australia over the 20-year period presents a not unexpected variety of tumour types. The dominant forms of cancer occurring in the salivary glands were mucoepidermoid carcinoma (21.5%), squamous cell carcinoma (13.9%), adenoid cystic carcinoma (10.2%), acinar (acinic) cell carcinoma (10.2%), adenocarcinoma NOS (9.6%) and malignant mixed tumour (7.0%).

As with other forms of oral cancer, salivary gland cancer occurred more frequently in elderly patients with the average age at diagnosis being 61.4 years in males and 61.9 years in females. This is confirmed by the highly significant statistical association between salivary gland cancer incidence and increasing patient age in both sexes. As with other types of oral cancer, salivary gland cancer occurred more commonly in males than females. It is interesting to note, however, that of the small number of

cases of salivary gland cancer reported in patients under 25 years of age (2.6% of all cases), 75% occurred in females.

The incidence of salivary gland cancer in South Australia between 1977-1996 was comparable to, or slightly higher than, most other parts of the world. The age-standardised male rate rarely exceeded 1.5 per 100,000 per annum and the female rate only rose above 1.0 per 100,000 per annum once, in 1983. There was no significant change in the incidence rates of salivary gland cancer in either sex over the 20-year period. There is limited published data on incidence rates of salivary gland cancer elsewhere in the world. Devesa *et al* (1995) reported that incidence rates for salivary gland cancer in the United States were stable in males between 1975-1991 and had fallen in females over the same period. In a more localised study, Horn-Ross *et al* (1991) noted a sudden and unexplained doubling in the incidence of salivary gland cancer among men only at the San Francisco-Oakland registry during the second part of the 1980's. In an extensive study of malignant salivary gland tumours in Sweden over the past three decades, Ostman *et al* (1997) reported a relatively stable overall incidence in both males and females, while noting variations in specific glands/ subsites. Hindle and Nally (1991) reported a decrease in the number of cases of salivary gland cancer in England and Wales in both sexes from 1962-7 to 1980-4.

In South Australia, salivary gland cancer accounted for 106 deaths (i.e. 18.8% of all oral cancer deaths) over the 20-year period. The age-standardised mortality rates were low with the male rate rarely exceeding 0.5 per 100,000 per annum and the female rate staying at or below 0.3 per 100,000 per annum for all but two years. These mortality rates remained stable over the 20-year period in both sexes.

5.7 The Need For Future Studies

This study of the epidemiology of oral cancer in South Australia over a 20-year period has raised some interesting questions and invites further investigation. More detailed analysis of the oral cancer data from the South Australian Cancer Registry and more extensive studies could be carried out. These might include:

i. Five-year survival rates

More detailed analysis of the lethality of oral cancer and particularly changes over the past decades could provide important information about the effectiveness of public health awareness measures, early diagnosis and treatment regimes. Other researchers (Gerson 1990; Johnson 1991; Daftary *et al* 1992; Antoniades *et al* 1995) have noted the relatively poor survival from oral cancer (excluding the lip), and it would be important to assess where South Australia stands in this regard.

ii. Age-specific cohort trends

Calculation of cancer incidence for various age cohorts by year of birth allows assessment of changes in occurrence within various age groups. Significant changes have been observed elsewhere in the world (Chen *et al* 1990a; Plesko *et al* 1994) and it would be interesting to see whether these are reflected in the South Australian data.

iii. Geographic trends

Geographic trends have been studied in terms of urban versus rural differences in cancer incidence and mortality (Schouten *et al* 1996). For oral cancer, this has been particularly related to lip cancer where sunlight is felt to be a key risk factor. The data could be further analysed to see whether similar trends have occurred in the South Australian population.

iv. Migrant studies

The rates of cancer incidence and mortality vary widely between different populations of the world. These variations could reflect differences in genetic predisposition and/or specific causative environmental factors of cancer. The study of migrant populations which change environments while retaining their genes, has been seen as a "natural experiment" to test the relative importance of genetic and environmental factors (Armstrong & McMichael 1984). Migrant studies have shown significantly raised risks of oral cancer for both Indian (Swerdlow et al 1995b) and African immigrants (Swerdlow *et al* 1992) to England and Wales. The best migrant studies compare the overall cancer rates in both the original and host countries with the migrant group. One such study on British and New Zealand migrant populations clearly demonstrated ethnic trends, especially in lip and salivary gland tumours (Swerdlow *et al* 1995a). Because of Australia's unique ethnic makeup, the result of decades of immigration, Armstrong and McMichael (1984) have described this nation as "a largely unused laboratory of natural experiments in human epidemiology". The South Australian cancer data could become a basis for further migrant studies into the various forms of oral cancer.

v. Aetiologic studies

Further research into the aetiology of oral cancer in South Australia is indicated. The important finding from this study that South Australia leads the world in lip cancer incidence, make it an obvious location for more detailed investigation into the risk factors of this important form of oral cancer.

Chapter Six

Conclusion

This study analysed the epidemiology of oral cancer in South Australia between 1977-1996. The more important findings and conclusions are:

- Evidence of an extremely high incidence of lip cancer in South Australia over the past 20 years. Male rates remain amongst the highest in the world although the incidence has plateaued in recent years. Female rates are also high and have continued to steadily increase between 1977-1996.
- The vast majority of oral cancer cases in South Australia between 1977-1996, occurred on the lip. This dominance by the lip site emphasises the importance of using a site-specific classification system in epidemiological studies of oral cancer. Combining all sites/subsites under the generic term "oral cancer" has the potential to mask trends in the individual sites.
- Other forms of oral cancer in South Australia have shown relatively low but stable incidence rates over the 20-year analysis period. The observation that rates are not decreasing points to the need for increasing public awareness of this disease, particularly the importance of exposure to known risk factors such as smoking and alcohol consumption.
- There is a need for further studies into the epidemiology of oral cancer, particularly lip cancer, in South Australia (See Section 5.7).

Appendix I

South Australian Parliament

Part IX(E)
No. 70 of 1976
An act to amend the Health Act, 1935-1975
(Assented to 2nd December, 1976)

The following heading and section are enacted and inserted in the principal Act after section 146X thereof: — Enactment of Part IXE of Principal Act

PART IXE
CANCER REPORTING

146Y. In this Part "cancer" means a malignant growth of human tissue which if unchecked, is likely to spread to adjacent tissue or beyond its place of origin, and which has the propensity to recur, and includes carcinoma, sarcoma, any mixed tumour, leukaemia, any type of lymphoma, and melanoma but does not include any type of neoplasm of the skin other than melanoma. — Interpretation

146Z. (1) The owner of occupier of any building used as a hospital shall, as soon as he or his manager or superintendent becomes aware that an inmate is suffering from cancer, report the same to the Central Board in the prescribed manner and form. — Duty to Report Cancer

(2) The person in charge of any place where pathological examination of specimens of human origin is undertaken shall, where any such examination indicates that the person from whom the specimen was taken is suffering from cancer, cause a copy of any report upon that examination to be forwarded to the Central Board.

Source: Bonett A, Roder D (1988). Epidemiology of Cancer in South Australia. Incidence, Mortality and Survival 1977 to 1986. Incidence and Mortality 1986. (Lutheran Publishing House: Adelaide).

Appendix II

Example of matrix used to calculate population-based age-standardised incidence and mortality rates
Shows calculation for lip cancer (140 ICD-9) incidence in South Australia, 1977-1996

LIP		PREVALENCE	Enter data into this matrix								
AGEGP	SEX	YEAR77	YEAR78	YEAR79	YEAR80	YEAR81	YEAR82	YEAR83	YEAR84	YEAR85	YEAR86
01	M										
02	M										
03	M										
04	M			1			2		1	1	
05	M					1			3	1	2
06	M	3	4	1	2	3	1	4	4	2	3
07	M	4	4	2		7	1	6	6	4	5
08	M	5	3	1	3	5	8	7	6	5	5
09	M	2	3	2	4	7	2	11	8	12	6
10	M	4	6	4	9	5	5	2	6	8	7
11	M	4	8	2	7	6	9	12	6	8	1
12	M	7	8	7	5	8	12	15	13	19	15
13	M	11	12	4	14	12	16	13	18	16	8
14	M	12	8	3	6	11	12	22	14	14	13
15	M	7	5	6	7	7	8	8	17	13	11
16	M	6	8	11	3	6	6	8	7	11	12
17	M	4	6	4	1	5	2	6	7	7	5
01	F										
02	F										
03	F										
04	F										
05	F								2		
06	F					1	1	1			1
07	F		1	1			1		1		1
08	F				1		4	1	2		2
09	F		1			2	2		1	1	3
10	F			1			3			3	1
11	F		1				1	1	2	3	
12	F			1			2	5	2		2
13	F		2	1	1	2	1	3	1	3	2
14	F	1	2	1	1	2	2	6	5	3	4
15	F	1	1	1	1	5	5	2	5	2	3
16	F		2	2	4	4	2		6	2	2
17	F	2	2	3	3	3	2	2	9	6	8
CRUDE	M	10.83	11.67	7.44	9.40	12.68	12.76	17.15	17.30	17.93	13.52
CRUDE	F	0.63	1.86	1.70	1.69	2.86	3.88	3.10	5.27	3.34	4.17

Appendix II cont.

Example of matrix used to calculate population-based age-standardised incidence and mortality rates
Shows calculation for lip cancer (140 ICD-9) incidence in South Australia, 1977-1996

LIP		PREVALENCE	Enter data into this matrix								
AGEGP	SEX	YEAR87	YEAR88	YEAR89	YEAR90	YEAR91	YEAR92	YEAR93	YEAR94	YEAR95	YEAR96
01	M										
02	M							1			
03	M		2	2							
04	M		4	1	3	1	1		3	1	
05	M	1	1	6	7	3	3	6	3	7	2
06	M	4	6	3	6	4	5	7	7	10	5
07	M	5	9	5	9	8	8	6	5	3	11
08	M	12	13	9	7	8	9	7	10	9	11
09	M	13	7	8	3	13	18	8	5	8	9
10	M	12	9	14	8	12	15	11	6	11	16
11	M	18	11	4	15	12	7	12	7	8	12
12	M	18	14	11	9	14	17	14	11	12	10
13	M	11	19	11	14	12	19	16	9	20	19
14	M	11	14	11	9	19	19	24	12	13	21
15	M	11	6	13	9	7	17	8	14	7	11
16	M	9	9	9	8	11	8	13	12	7	18
17	M										
01	F										
02	F										
03	F	1									
04	F										
05	F	1	1		3						2
06	F	1	4	1	2	2		1	1		
07	F		1	1	2	1	3	3			1
08	F		3			2	2	6	8	2	3
09	F		2			1	3	2	3	4	1
10	F	1	1	3	2	2	2	4		2	5
11	F	3	3			3	2	2	2	2	
12	F	3	2	3	4	2	6	3	5	1	6
13	F	4	6	5	7	3	5	6	7	3	9
14	F	2	1	3	8	4	2	2	7	7	14
15	F	5	2	5	9	7	12	4	11	6	7
16	F	5	9	7	14	12	11	10	13	13	14
17	F										
CRUDE	M	18.02	17.70	15.09	14.93	17.08	20.17	18.33	14.25	15.85	19.74
CRUDE	F	3.71	4.95	3.91	7.06	5.34	6.52	5.84	7.70	5.39	8.33

Appendix II cont.

Example of matrix used to calculate population-based age-standardised incidence and mortality rates
Shows calculation for lip cancer (140 ICD-9) incidence in South Australia, 1977-1996

LIP AGEGP	SEX	INCIDENCE YEAR77	YEAR78	YEAR79	YEAR80	YEAR81	YEAR82	YEAR83	YEAR84	YEAR85	YEAR86
01	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04	M	0.00	0.00	1.61	0.00	0.00	3.43	0.00	1.74	1.74	0.00
05	M	0.00	0.00	0.00	0.00	1.71	0.00	0.00	5.09	1.71	3.37
06	M	5.77	7.61	1.90	3.78	5.52	1.83	7.22	7.14	3.53	5.08
07	M	8.55	8.20	3.97	0.00	13.09	1.89	11.21	11.09	7.37	9.23
08	M	13.32	7.81	2.53	7.30	11.87	17.49	14.44	11.88	9.55	9.19
09	M	5.88	8.73	5.77	11.27	19.64	5.47	29.22	20.63	29.64	13.98
10	M	10.89	16.91	11.58	26.87	15.19	15.20	6.06	17.78	23.31	19.52
11	M	10.80	21.31	5.36	18.82	16.45	25.36	34.89	17.95	24.68	3.07
12	M	22.16	24.42	20.52	14.47	22.73	33.75	41.78	36.17	53.15	42.41
13	M	40.94	44.83	15.16	51.67	42.66	54.92	42.75	56.68	48.94	24.11
14	M	58.26	37.44	13.37	25.92	45.05	49.03	90.12	58.28	57.62	51.07
15	M	50.72	34.77	40.44	45.28	42.14	45.81	43.85	88.48	64.85	53.99
16	M	72.60	94.32	123.62	32.71	60.25	58.04	73.95	61.30	92.62	95.58
17	M	61.04	88.40	57.63	13.90	65.43	25.22	73.26	80.82	76.71	51.73
01	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.42	0.00	0.00
06	F	0.00	0.00	0.00	0.00	1.87	1.86	1.85	0.00	0.00	1.74
07	F	0.00	2.10	2.02	0.00	0.00	1.91	0.00	1.88	0.00	1.85
08	F	0.00	0.00	0.00	2.52	0.00	8.75	2.07	3.97	0.00	3.73
09	F	0.00	2.96	0.00	0.00	5.63	5.51	0.00	2.61	2.49	7.15
10	F	0.00	0.00	3.03	0.00	0.00	9.30	0.00	0.00	8.68	2.84
11	F	0.00	2.77	0.00	0.00	0.00	2.92	2.99	6.13	9.34	0.00
12	F	0.00	0.00	2.91	0.00	0.00	5.61	14.06	5.62	0.00	5.84
13	F	0.00	7.08	3.61	3.57	6.48	3.12	9.06	2.92	8.58	5.72
14	F	4.19	8.11	3.89	3.79	7.30	7.23	21.50	17.99	10.63	13.73
15	F	5.68	5.43	5.19	4.99	23.36	22.19	8.56	20.52	7.94	11.82
16	F	0.00	15.10	14.93	28.81	27.50	13.21	0.00	35.58	11.35	10.91
17	F	13.46	13.02	18.83	18.49	17.42	11.26	11.09	48.21	30.96	39.02
5 yr CUM.	M	10.62	11.61	8.93	7.41	10.64	9.92	13.79	13.97	14.57	11.24
5 yr CUM.	F	0.69	1.66	1.60	1.83	2.63	2.73	2.09	4.38	2.65	3.07

Appendix II cont.

Example of matrix used to calculate population-based age-standardised incidence and mortality rates
Shows calculation for lip cancer (140 ICD-9) incidence in South Australia, 1977-1996

LIP AGEGP	SEX	INCIDENCE YEAR87	YEAR88	YEAR89	YEAR90	YEAR91	YEAR92	YEAR93	YEAR94	YEAR95	YEAR96
01	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02	M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03	M	0.00	0.00	0.00	0.00	0.00	0.00	1.96	0.00	0.00	0.00
04	M	0.00	3.36	3.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05	M	0.00	6.84	1.71	5.05	1.64	1.69	0.00	5.18	1.78	0.00
06	M	1.67	1.64	9.69	11.27	4.84	5.19	10.60	5.34	12.44	3.51
07	M	7.25	10.67	5.18	10.07	6.50	8.30	11.73	11.68	16.94	8.69
08	M	9.37	16.73	9.19	16.48	14.39	14.25	10.62	8.74	5.17	18.65
09	M	25.59	26.29	17.46	13.02	14.41	16.68	12.96	18.50	16.63	20.21
10	M	35.46	18.49	20.39	7.34	30.42	39.17	16.48	9.88	15.37	16.86
11	M	36.46	27.21	41.68	23.26	34.23	41.31	29.58	15.63	27.42	38.24
12	M	52.69	33.13	12.26	47.58	38.20	21.95	37.12	21.25	23.83	34.89
13	M	53.95	41.61	32.85	26.86	42.40	52.31	44.59	35.68	39.91	33.58
14	M	41.30	68.49	37.95	47.50	40.42	62.06	51.92	29.30	64.91	62.64
15	M	53.39	68.28	54.49	43.93	88.16	82.78	100.79	48.05	51.27	81.63
16	M	83.54	43.44	88.89	59.45	45.27	109.15	50.52	89.05	43.05	64.04
17	M	88.52	84.60	80.07	66.98	87.37	63.09	94.34	83.38	46.16	112.82
01	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04	F	1.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06	F	1.73	1.71	0.00	5.10	0.00	0.00	0.00	0.00	0.00	3.69
07	F	1.83	7.21	1.77	3.44	3.37	0.00	1.68	1.69	0.00	0.00
08	F	0.00	1.86	1.83	3.64	1.80	5.32	5.31	0.00	0.00	1.70
09	F	0.00	6.22	0.00	0.00	3.70	3.72	11.14	14.77	3.68	5.50
10	F	0.00	5.44	0.00	0.00	2.40	6.63	4.16	5.96	7.75	1.89
11	F	3.11	3.09	9.05	5.85	5.77	5.60	11.00	0.00	5.09	12.09
12	F	9.05	9.24	0.00	0.00	9.73	6.29	6.18	6.04	5.95	0.00
13	F	8.59	5.78	8.75	11.84	6.03	18.23	9.43	15.99	3.24	19.72
14	F	13.19	19.07	15.35	21.22	9.05	15.02	18.08	21.20	9.23	28.17
15	F	7.84	3.90	11.88	31.25	14.97	7.13	6.87	23.32	22.90	45.55
16	F	26.20	10.04	23.72	41.50	31.79	54.91	18.03	50.12	26.77	29.74
17	F	23.33	40.21	30.14	57.48	46.97	44.52	36.65	45.81	44.07	45.57
5 yr CUM.	M	14.39	13.26	12.21	11.14	13.18	15.23	13.92	11.23	10.73	14.58
5 yr CUM.	F	2.84	3.35	3.01	5.33	3.99	4.92	3.78	5.44	3.78	5.69

Appendix II cont.

Example of matrix used to calculate population-based age-standardised incidence and mortality rates
Shows calculation for lip cancer (140 ICD-9) incidence in South Australia, 1977-1996

LIP	WORLD STANDARD	calculation matrix									
AGEGP	SEX	YEAR77	YEAR78	YEAR79	YEAR80	YEAR81	YEAR82	YEAR83	YEAR84	YEAR85	YEAR86
01	M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
02	M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
03	M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
04	M	0.0000	0.0000	0.1452	0.0000	0.0000	0.3085	0.0000	0.1563	0.1569	0.0000
05	M	0.0000	0.0000	0.0000	0.0000	0.1369	0.0000	0.0000	0.4074	0.1368	0.2699
06	M	0.4620	0.6087	0.1516	0.3023	0.4417	0.1465	0.5778	0.5715	0.2825	0.4066
07	M	0.5133	0.4918	0.2382	0.0000	0.7857	0.1133	0.6724	0.6655	0.4419	0.5536
08	M	0.7993	0.4683	0.1516	0.4380	0.7124	1.0492	0.8662	0.7128	0.5732	0.5514
09	M	0.3526	0.5237	0.3460	0.6761	1.1782	0.3284	1.7530	1.2380	1.7785	0.8386
10	M	0.6533	1.0146	0.6950	1.6122	0.9115	0.9121	0.3633	1.0670	1.3986	1.1713
11	M	0.5401	1.0654	0.2681	0.9410	0.8223	1.2679	1.7445	0.8975	1.2339	0.1534
12	M	0.8863	0.9767	0.8209	0.5787	0.9093	1.3501	1.6710	1.4470	2.1259	1.6964
13	M	1.6378	1.7933	0.6064	2.0670	1.7063	2.1969	1.7100	2.2672	1.9576	0.9643
14	M	1.7479	1.1233	0.4011	0.7775	1.3514	1.4708	2.7036	1.7483	1.7286	1.5322
15	M	1.0144	0.6953	0.8087	0.9055	0.8427	0.9161	0.8770	1.7695	1.2970	1.0798
16	M	0.7260	0.9432	1.2362	0.3271	0.6025	0.5804	0.7395	0.6130	0.9262	0.9558
17	M	0.6104	0.8840	0.5763	0.1390	0.6543	0.2522	0.7326	0.8082	0.7671	0.5173
01	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
02	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
03	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
04	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
05	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2740	0.0000	0.0000
06	F	0.0000	0.0000	0.0000	0.0000	0.1499	0.1486	0.1478	0.0000	0.0000	0.1395
07	F	0.0000	0.1261	0.1210	0.0000	0.0000	0.1147	0.0000	0.1126	0.0000	0.1108
08	F	0.0000	0.0000	0.0000	0.1513	0.0000	0.5247	0.1241	0.2381	0.0000	0.2239
09	F	0.0000	0.1778	0.0000	0.0000	0.3376	0.3306	0.0000	0.1567	0.1495	0.4289
10	F	0.0000	0.0000	0.1816	0.0000	0.0000	0.5580	0.0000	0.0000	0.5207	0.1704
11	F	0.0000	0.1387	0.0000	0.0000	0.0000	0.1461	0.1497	0.3066	0.4672	0.0000
12	F	0.0000	0.0000	0.1165	0.0000	0.0000	0.2244	0.5623	0.2248	0.0000	0.2337
13	F	0.0000	0.2832	0.1445	0.1427	0.2592	0.1247	0.3622	0.1169	0.3431	0.2287
14	F	0.1257	0.2432	0.1166	0.1136	0.2191	0.2169	0.6451	0.5397	0.3189	0.4120
15	F	0.1137	0.1086	0.1038	0.0998	0.4672	0.4437	0.1711	0.4105	0.1587	0.2365
16	F	0.0000	0.1510	0.1493	0.2881	0.2750	0.1321	0.0000	0.3558	0.1135	0.1091
17	F	0.1346	0.1302	0.1883	0.1849	0.1742	0.1126	0.1109	0.4821	0.3096	0.3902
World standard	M	9.9433	10.5884	6.4455	8.7644	11.0551	10.8924	14.4109	14.3692	14.8048	10.6905
World standard	F	0.3739	1.3587	1.1216	0.9804	1.8821	3.0771	2.2731	3.2178	2.3811	2.6838
CI upper	M	12.2995	13.0002	8.2891	10.9856	13.4638	13.2485	17.0856	17.0218	17.4911	12.9033
CI lower	M	7.5870	8.1766	4.6018	6.5433	8.6465	8.5362	11.7362	11.7166	12.1185	8.4776
CI upper	F	0.7548	2.1622	1.8267	1.5948	2.7796	4.3206	3.2662	4.3401	3.4432	3.7333
CI lower	F	-0.0070	0.5552	0.4165	0.3660	0.9845	1.8336	1.2800	2.0954	1.3191	1.6343

Appendix II cont.

Example of matrix used to calculate population-based age-standardised incidence and mortality rates
Shows calculation for lip cancer (140 ICD-9) incidence in South Australia, 1977-1996

LIP	WORLD STANDARD	calculation matrix									
AGEGP	SEX	YEAR87	YEAR88	YEAR89	YEAR90	YEAR91	YEAR92	YEAR93	YEAR94	YEAR95	YEAR96
01	M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
02	M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
03	M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1768	0.0000	0.0000	0.0000
04	M	0.0000	0.3026	0.3062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
05	M	0.0000	0.5471	0.1365	0.4038	0.1314	0.1353	0.0000	0.4142	0.1423	0.0000
06	M	0.1335	0.1312	0.7750	0.9016	0.3875	0.4152	0.8480	0.4275	0.9949	0.2810
07	M	0.4351	0.6401	0.3111	0.6043	0.3903	0.4981	0.7038	0.7008	1.0167	0.5213
08	M	0.5622	1.0036	0.5515	0.9890	0.8636	0.8549	0.6370	0.5246	0.3102	1.1193
09	M	1.5356	1.5776	1.0477	0.7814	0.8644	1.0009	0.7776	1.1102	0.9976	1.2126
10	M	2.1277	1.1096	1.2235	0.4405	1.8252	2.3505	0.9886	0.5931	0.9224	1.0115
11	M	1.8232	1.3605	2.0841	1.1629	1.7117	2.0656	1.4790	0.7815	1.3712	1.9119
12	M	2.1075	1.3251	0.4905	1.9034	1.5280	0.8780	1.4848	0.8499	0.9532	1.3956
13	M	2.1579	1.6644	1.3139	1.0745	1.6958	2.0924	1.7836	1.4271	1.5965	1.3433
14	M	1.2391	2.0548	1.1385	1.4249	1.2125	1.8619	1.5577	0.8789	1.9473	1.8793
15	M	1.0678	1.3656	1.0899	0.8786	1.7633	1.6556	2.0158	0.9611	1.0253	1.6327
16	M	0.8354	0.4344	0.8889	0.5945	0.4527	1.0915	0.5052	0.8905	0.4305	0.6404
17	M	0.8852	0.8460	0.8007	0.6698	0.8737	0.6309	0.9434	0.8338	0.4616	1.1282
01	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
02	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
03	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
04	F	0.1588	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
05	F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
06	F	0.1381	0.1365	0.0000	0.4077	0.0000	0.0000	0.0000	0.0000	0.0000	0.2949
07	F	0.1096	0.4324	0.1059	0.2066	0.2022	0.0000	0.1007	0.1014	0.0000	0.0000
08	F	0.0000	0.1116	0.1096	0.2182	0.1078	0.3189	0.3188	0.0000	0.0000	0.1019
09	F	0.0000	0.3731	0.0000	0.0000	0.2223	0.2232	0.6684	0.8863	0.2205	0.3302
10	F	0.0000	0.3263	0.0000	0.0000	0.1439	0.3980	0.2494	0.3578	0.4651	0.1131
11	F	0.1554	0.1543	0.4524	0.2924	0.2886	0.2802	0.5502	0.0000	0.2545	0.6044
12	F	0.3620	0.3696	0.0000	0.0000	0.3891	0.2516	0.2473	0.2417	0.2380	0.0000
13	F	0.3437	0.2311	0.3500	0.4737	0.2411	0.7290	0.3773	0.6397	0.1296	0.7889
14	F	0.3956	0.5722	0.4605	0.6365	0.2716	0.4506	0.5423	0.6359	0.2768	0.8450
15	F	0.1568	0.0781	0.2376	0.6250	0.2993	0.1426	0.1374	0.4663	0.4581	0.9110
16	F	0.2620	0.1004	0.2372	0.4150	0.3179	0.5491	0.1803	0.5012	0.2677	0.2974
17	F	0.2333	0.4021	0.3014	0.5748	0.4697	0.4452	0.3665	0.4581	0.4407	0.4557
World standard	M	14.9103	14.3626	12.1580	11.8291	13.7003	15.5308	13.9012	10.3933	12.1697	14.0770
World standard	F	2.3154	3.2877	2.2546	3.8500	2.9535	3.7886	3.7386	4.2883	2.7509	4.7424
CI upper	M	17.5757	16.9293	14.5206	14.1122	16.1619	18.1115	16.3249	12.4531	14.4372	16.4348
CI lower	M	12.2449	11.7959	9.7954	9.5460	11.2387	12.9501	11.4775	8.3335	9.9023	11.7192
CI upper	F	3.2748	4.4591	3.1692	5.0076	3.9877	4.9728	4.9521	5.5123	3.7077	6.0512
CI lower	F	1.3561	2.1163	1.3400	2.6923	1.9192	2.6044	2.5252	3.0643	1.7941	3.4336

Appendix III

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Oral Cancer (140-5 ICD-9) - Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	14.8484	14.4409	11.9343	13.3258	17.5405	16.4819	18.5688	20.0892	20.0830	15.8102
World standard F	1.8605	3.6430	3.7385	3.1095	3.7727	4.7777	5.7368	5.0753	4.2517	4.0100
CI upper M	17.7149	17.2613	14.4534	16.0318	20.5435	19.3608	21.5949	23.2071	23.1998	18.5143
CI lower M	11.9819	11.6204	9.4151	10.6199	14.5375	13.6031	15.5427	16.9713	16.9663	13.1061
CI upper F	2.8226	4.9543	5.0443	4.2955	5.0400	6.3122	7.3527	6.4998	5.6265	5.2988
CI lower F	0.8984	2.3317	2.4328	1.9234	2.5053	3.2432	4.1209	3.6508	2.8769	2.7212

Oral Cancer (140-5 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	19.7009	19.3459	18.1794	16.5268	17.8547	20.8307	18.7653	15.4348	16.9271	19.1376
World standard F	5.2832	5.9859	5.4381	6.4424	4.9075	5.8468	5.4328	6.6171	5.4301	7.2637
CI upper M	22.7548	22.3317	21.0612	19.2342	20.6516	23.8161	21.5635	17.9599	19.6052	21.8948
CI lower M	16.6470	16.3602	15.2976	13.8194	15.0579	17.8452	15.9672	12.9096	14.2490	16.3805
CI upper F	6.7359	7.5362	6.9338	7.9735	6.2833	7.3094	6.8990	8.1956	6.8233	8.8845
CI lower F	3.8304	4.4356	3.9424	4.9113	3.5317	4.3842	3.9665	5.0386	4.0369	5.6429

Lip Cancer (140 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	9.9433	10.5884	6.4455	8.7644	11.0551	10.8924	14.4109	14.3692	14.8048	10.6905
World standard F	0.3739	1.3587	1.1216	0.9804	1.8821	3.0771	2.2731	3.2178	2.3811	2.6838
CI upper M	12.2995	13.0002	8.2891	10.9856	13.4638	13.2485	17.0856	17.0218	17.4911	12.9033
CI lower M	7.5870	8.1766	4.6018	6.5433	8.6465	8.5362	11.7362	11.7166	12.1185	8.4776
CI upper F	0.7548	2.1622	1.8267	1.5948	2.7796	4.3206	3.2662	4.3401	3.4432	3.7333
CI lower F	-0.0070	0.5552	0.4165	0.3660	0.9845	1.8336	1.2800	2.0954	1.3191	1.6343

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Lip Cancer (140 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	14.9103	14.3626	12.1580	11.8291	13.7003	15.5308	13.9012	10.3933	12.1697	14.0770
World standard F	2.3154	3.2877	2.2546	3.8500	2.9535	3.7886	3.7386	4.2883	2.7509	4.7424
CI upper M	17.5757	16.9293	14.5206	14.1122	16.1619	18.1115	16.3249	12.4531	14.4372	16.4348
CI lower M	12.2449	11.7959	9.7954	9.5460	11.2387	12.9501	11.4775	8.3335	9.9023	11.7192
CI upper F	3.2748	4.4591	3.1692	5.0076	3.9877	4.9728	4.9521	5.5123	3.7077	6.0512
CI lower F	1.3561	2.1163	1.3400	2.6923	1.9192	2.6044	2.5252	3.0643	1.7941	3.4336

Tongue Cancer (141 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	1.6528	1.3244	1.7974	1.4974	2.4878	2.4526	1.2312	1.6283	1.7257	1.7336
World standard F	0.6456	0.7531	0.8943	1.0575	0.6842	0.7383	1.0282	0.6960	0.7048	0.8757
CI upper M	2.5906	2.1997	2.7815	2.3902	3.6143	3.5399	2.0042	2.4915	2.6051	2.6534
CI lower M	0.7149	0.4492	0.8132	0.6047	1.3613	1.3652	0.4582	0.7651	0.8462	0.8138
CI upper F	1.1910	1.3437	1.5811	1.7607	1.2350	1.3525	1.7058	1.2175	1.2305	1.5023
CI lower F	0.1003	0.1625	0.2075	0.3543	0.1334	0.1241	0.3506	0.1744	0.1791	0.2492

Tongue Cancer (141 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	1.7145	1.9891	2.4056	1.9561	1.2860	1.5570	2.0458	1.7129	1.2571	2.0194
World standard F	0.9296	0.3464	1.1612	0.4611	0.8223	0.2918	0.4321	0.6223	0.5180	0.9438
CI upper M	2.5920	2.9469	3.4537	2.9072	1.9954	2.3614	2.9669	2.5645	2.0106	2.9264
CI lower M	0.8371	1.0314	1.3575	1.0050	0.5765	0.7526	1.1247	0.8614	0.5037	1.1123
CI upper F	1.5575	0.6613	1.8592	0.8640	1.3878	0.6239	0.8426	1.1396	0.9318	1.5265
CI lower F	0.3018	0.0316	0.4631	0.0582	0.2568	-0.0402	0.0216	0.1050	0.1042	0.3611

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Mouth Cancer (143-5 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	2.2632	1.6821	1.6826	1.7640	2.5520	1.5149	1.9074	2.7355	2.5740	2.5408
World standard F	0.2555	0.9107	1.2775	0.3297	0.5691	0.4960	1.3656	0.8288	0.7526	0.2686
CI upper M	3.3793	2.6354	2.6465	2.7267	3.6782	2.3858	2.8521	3.8662	3.6936	3.6450
CI lower M	1.1471	0.7289	0.7187	0.8012	1.4258	0.6441	0.9626	1.6049	1.4544	1.4366
CI upper F	0.6377	1.5299	2.0351	0.6604	1.0055	0.9666	2.1558	1.4251	1.3057	0.5886
CI lower F	-0.1268	0.2915	0.5200	-0.0010	0.1327	0.0255	0.5755	0.2325	0.1996	-0.0513

Mouth Cancer (143-5 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	1.9941	2.5279	2.6248	2.4040	2.3504	2.5657	1.7762	1.9356	2.1251	2.1251
World standard F	1.2592	1.7292	1.3362	1.8938	0.4970	1.0690	0.6513	1.0715	1.5284	1.1633
CI upper M	2.9863	3.6233	3.7168	3.4346	3.3701	3.6330	2.6154	2.8290	3.0704	3.0765
CI lower M	1.0019	1.4324	1.5328	1.3734	1.3308	1.4983	0.9369	1.0422	1.1798	1.1737
CI upper F	1.9432	2.5393	2.0836	2.7644	0.8890	1.6543	1.1729	1.7174	2.3283	1.8254
CI lower F	0.5753	0.9191	0.5888	1.0232	0.1050	0.4837	0.1297	0.4257	0.7285	0.5012

Gum Cancer (143 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.0000	0.1404	0.2778	0.0000	0.0000	0.0967	0.2568	0.5549	0.0000	0.2481
World standard F	0.0000	0.1406	0.0628	0.1440	0.0581	0.1451	0.0554	0.2923	0.1587	0.0000
CI upper M	0.0000	0.4156	0.6630	0.0000	0.0000	0.2864	0.6158	1.0454	0.0000	0.5932
CI lower M	0.0000	-0.1348	-0.1075	0.0000	0.0000	-0.0929	-0.1022	0.0644	0.0000	-0.0971
CI upper F	0.0000	0.3360	0.1858	0.3436	0.1718	0.3511	0.1641	0.6546	0.3787	0.0000
CI lower F	0.0000	-0.0548	-0.0603	-0.0556	-0.0557	-0.0609	-0.0532	-0.0699	-0.0613	0.0000

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Gum Cancer (143 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	0.3934	0.6991	0.4041	0.2335	0.1575	0.0000	0.3171	0.1297	0.2383	0.0777
World standard F	0.0784	0.1156	0.1959	0.2192	0.0454	0.3122	0.0687	0.0908	0.0000	0.0651
CI upper M	0.8454	1.2693	0.8038	0.4993	0.3792	0.0000	0.6318	0.3840	0.5686	0.2301
CI lower M	-0.0586	0.1289	0.0044	-0.0322	-0.0642	0.0000	0.0023	-0.1245	-0.0920	-0.0746
CI upper F	0.2321	0.3420	0.4722	0.4491	0.1344	0.6034	0.2034	0.2689	0.0000	0.1926
CI lower F	-0.0753	-0.1109	-0.0805	-0.0108	-0.0436	0.0211	-0.0660	-0.0872	0.0000	-0.0625

Floor of Mouth Cancer (144 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.8532	1.2532	1.1702	1.0608	1.2951	0.8756	0.8440	1.0726	0.9536	0.7257
World standard F	0.0758	0.5210	0.6309	0.1136	0.2363	0.0000	0.4094	0.2249	0.1063	0.0000
CI upper M	1.5372	2.0735	1.9918	1.8000	2.1056	1.5273	1.4749	1.7788	1.6261	1.3140
CI lower M	0.1693	0.4329	0.3486	0.3217	0.4846	0.2239	0.2131	0.3663	0.2810	0.1375
CI upper F	0.2243	1.0326	1.1600	0.3364	0.5142	0.0000	0.8246	0.5368	0.3147	0.0000
CI lower F	-0.0727	0.0094	0.1018	-0.1091	-0.0415	0.0000	-0.0058	-0.0870	-0.1021	0.0000

Floor of Mouth Cancer (144 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	0.6652	0.8149	1.2655	1.0669	1.3583	1.4469	1.1056	0.8923	0.5119	0.7903
World standard F	0.3404	0.7084	0.2088	0.4955	0.1297	0.3690	0.0451	0.3099	0.2680	0.2628
CI upper M	1.2553	1.4199	2.0610	1.7717	2.1331	2.2531	1.7724	1.4925	0.9655	1.3835
CI lower M	0.0751	0.2099	0.4700	0.3620	0.5836	0.6407	0.4389	0.2921	0.0582	0.1971
CI upper F	0.7021	1.2251	0.5001	0.9554	0.3230	0.7279	0.1334	0.6424	0.5776	0.5434
CI lower F	-0.0213	0.1916	-0.0826	0.0356	-0.0636	0.0100	-0.0433	-0.0226	-0.0416	-0.0178

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Other Mouth Cancer (145 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	1.4100	0.2885	0.2346	0.7031	1.2569	0.5426	0.8066	1.1081	1.6204	1.5670
World standard F	0.1797	0.2492	0.5839	0.0720	0.2747	0.3510	0.9008	0.3116	0.4876	0.2686
CI upper M	2.2920	0.6886	0.5596	1.3200	2.0389	1.0883	1.4112	1.8422	2.5155	2.4354
CI lower M	0.5280	-0.1116	-0.0905	0.0863	0.4749	-0.0031	0.2019	0.3740	0.7253	0.6986
CI upper F	0.5319	0.5381	1.1119	0.2132	0.5914	0.7740	1.5643	0.6681	0.9503	0.5886
CI lower F	-0.1725	-0.0397	0.0558	-0.0691	-0.0420	-0.0721	0.2374	-0.0449	0.0249	-0.0513

Other Mouth Cancer (145 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	0.9355	1.0139	0.9552	1.1037	0.8346	1.1188	0.3535	0.9136	1.3749	1.2571
World standard F	0.8404	0.9053	0.9316	1.1792	0.3219	0.3878	0.5375	0.6708	1.2604	0.8354
CI upper M	1.5927	1.7272	1.5876	1.8070	1.4593	1.8182	0.7544	1.5245	2.1357	1.9851
CI lower M	0.2783	0.3006	0.3228	0.4003	0.2100	0.4193	-0.0475	0.3027	0.6142	0.5290
CI upper F	1.4002	1.4866	1.5620	1.8816	0.6511	0.7470	1.0336	1.1951	1.9980	1.4214
CI lower F	0.2806	0.3239	0.3012	0.4767	-0.0073	0.0286	0.0414	0.1465	0.5229	0.2494

Salivary Gland Cancer (142 ICD-9) – Incidence

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.9891	0.8459	2.0089	1.3000	1.4455	1.6220	1.0193	1.3562	0.9786	0.8453
World standard F	0.5855	0.6205	0.4451	0.7419	0.6374	0.4663	1.0699	0.3327	0.4132	0.1818
CI upper M	1.7236	1.5265	3.0333	2.1152	2.2697	2.5140	1.7357	2.1696	1.6649	1.4371
CI lower M	0.2546	0.1653	0.9845	0.4847	0.6214	0.7300	0.3030	0.5427	0.2924	0.2535
CI upper F	1.1660	1.2049	0.8479	1.3941	1.1912	0.9244	1.8056	0.7093	0.8372	0.4360
CI lower F	0.0050	0.0360	0.0423	0.0897	0.0835	0.0082	0.3342	-0.0439	-0.0109	-0.0724

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Salivary Gland Cancer (142 ICD-9) - Incidence

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	1.0820	0.4664	0.9910	0.3375	0.5180	1.1772	1.0421	1.3930	1.3751	0.9162
World standard F	0.7789	0.6226	0.6862	0.2376	0.6347	0.6974	0.6108	0.6349	0.6328	0.4142
CI upper M	1.7657	0.9238	1.6482	0.7256	0.9873	1.8602	1.6765	2.1741	2.1299	1.4773
CI lower M	0.3982	0.0089	0.3338	-0.0506	0.0487	0.4942	0.4077	0.6118	0.6203	0.3551
CI upper F	1.3518	1.1479	1.2817	0.5271	1.2260	1.2303	1.0975	1.1906	1.0961	0.7832
CI lower F	0.2059	0.0972	0.0906	-0.0519	0.0434	0.1645	0.1240	0.0792	0.1695	0.0452

Oral Cancer (140-5 ICD-9) - Mortality

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	1.8558	2.2373	2.5173	2.6145	1.7489	2.8152	3.2870	2.4073	1.8926	1.6352
World standard F	0.5246	0.7481	0.6496	0.6449	0.4447	0.7734	0.8278	0.4198	0.4684	0.7160
CI upper M	2.8679	3.3410	3.6896	3.8013	2.6707	3.9741	4.5480	3.4822	2.8254	2.5026
CI lower M	0.8437	1.1336	1.3450	1.4276	0.8271	1.6563	2.0261	1.3324	0.9597	0.7678
CI upper F	1.0237	1.3293	1.1287	1.1879	0.8498	1.3336	1.4406	0.8042	0.9164	1.2040
CI lower F	0.0254	0.1670	0.1705	0.1019	0.0395	0.2132	0.2150	0.0355	0.0204	0.2279

Oral Cancer (140-5 ICD-9) - Mortality

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	2.1906	2.1670	0.8979	2.6095	2.4624	2.2432	2.3887	1.9739	2.4972	2.1302
World standard F	0.5823	0.3851	0.8489	0.6130	0.9539	0.7057	0.8386	0.9256	0.6905	1.0119
CI upper M	3.1452	3.1350	1.5247	3.6708	3.4687	3.1802	3.3588	2.8186	3.4643	3.0738
CI lower M	1.2360	1.1990	0.2712	1.5482	1.4561	1.3061	1.4186	1.1291	1.5302	1.1865
CI upper F	1.0938	0.6804	1.4146	1.0415	1.4978	1.2318	1.3580	1.5094	1.2114	1.5821
CI lower F	0.0709	0.0898	0.2833	0.1846	0.4100	0.1796	0.3191	0.3418	0.1697	0.4417

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Lip Cancer (140 ICD-9) – Mortality

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.0000	0.4147	0.1173	0.1090	0.0000	0.2498	0.0924	0.2508	0.1224	0.0796
World standard F	0.0000	0.0000	0.0628	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CI upper M	0.0000	0.8865	0.3471	0.3228	0.0000	0.5977	0.2736	0.5985	0.3622	0.2358
CI lower M	0.0000	-0.0571	-0.1126	-0.1047	0.0000	-0.0981	-0.0887	-0.0968	-0.1175	-0.0765
CI upper F	0.0000	0.0000	0.1858	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CI lower F	0.0000	0.0000	-0.0603	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Lip Cancer (140 ICD-9) - Mortality

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	0.1171	0.0724	0.0000	0.0000	0.1211	0.1284	0.0632	0.1186	0.2835	0.0989
World standard F	0.3059	0.0000	0.0431	0.0411	0.0000	0.1258	0.0451	0.1019	0.0000	0.1401
CI upper M	0.3466	0.2143	0.0000	0.0000	0.3585	0.3064	0.1869	0.3511	0.6161	0.2928
CI lower M	-0.1124	-0.0695	0.0000	0.0000	-0.1163	-0.0496	-0.0606	-0.1139	-0.0491	-0.0950
CI upper F	0.7319	0.0000	0.1274	0.1215	0.0000	0.3724	0.1334	0.2496	0.0000	0.3052
CI lower F	-0.1201	0.0000	-0.0413	-0.0394	0.0000	-0.1208	-0.0433	-0.0459	0.0000	-0.0250

Tongue Cancer (141 ICD-9) – Mortality

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.8792	0.2611	1.0711	0.7998	0.2365	1.1039	0.8930	1.0356	0.3577	0.5580
World standard F	0.2429	0.1598	0.2421	0.3270	0.2771	0.2494	0.5119	0.2493	0.1587	0.1764
CI upper M	1.5832	0.6238	1.8698	1.4488	0.5646	1.8316	1.5654	1.7338	0.7629	1.0481
CI lower M	0.1752	-0.1015	0.2724	0.1507	-0.0915	0.3763	0.2207	0.3373	-0.0475	0.0678
CI upper F	0.6114	0.4731	0.5293	0.7175	0.6013	0.5950	1.0159	0.5395	0.3787	0.3817
CI lower F	-0.1257	-0.1534	-0.0451	-0.0635	-0.0471	-0.0962	0.0078	-0.0408	-0.0613	-0.0289

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Tongue Cancer (141 ICD-9) - Mortality

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	1.1825	0.9396	0.2389	1.4748	0.9086	1.0876	0.8403	0.8634	0.9460	0.4825
World standard F	0.1456	0.1674	0.1335	0.2504	0.3285	0.3008	0.1138	0.2911	0.1577	0.1881
CI upper M	1.8979	1.5688	0.5700	2.2630	1.5109	1.7407	1.4352	1.4122	1.5419	0.9565
CI lower M	0.4670	0.3104	-0.0922	0.6867	0.3062	0.4345	0.2454	0.3147	0.3501	0.0085
CI upper F	0.3599	0.3643	0.2848	0.5539	0.6922	0.6549	0.2749	0.6524	0.3794	0.4334
CI lower F	-0.0688	-0.0294	-0.0177	-0.0531	-0.0351	-0.0533	-0.0473	-0.0702	-0.0640	-0.0571

Mouth Cancer (143-5 ICD-9) – Mortality

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.7099	1.1468	0.5302	1.0994	1.0188	0.8349	1.2036	0.6407	0.9468	0.6132
World standard F	0.1431	0.2057	0.2701	0.3179	0.1095	0.2211	0.1109	0.1705	0.1361	0.2060
CI upper M	1.3352	1.9477	1.0512	1.8656	1.7285	1.4592	1.9560	1.2058	1.6045	1.1562
CI lower M	0.0847	0.3459	0.0092	0.3332	0.3091	0.2106	0.4511	0.0756	0.2891	0.0702
CI upper F	0.3417	0.4390	0.6025	0.6953	0.3242	0.4848	0.2645	0.4226	0.3273	0.4915
CI lower F	-0.0556	-0.0277	-0.0624	-0.0594	-0.1051	-0.0426	-0.0428	-0.0816	-0.0551	-0.0795

Mouth Cancer (143-5 ICD-9) - Mortality

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	0.5997	0.8232	0.6591	1.0510	1.2129	0.7778	0.9860	0.7033	0.6876	0.8714
World standard F	0.1308	0.1730	0.5557	0.2434	0.5862	0.2790	0.4806	0.4974	0.3586	0.6511
CI upper M	1.0841	1.4385	1.1913	1.7425	1.9154	1.3592	1.5969	1.2306	1.1691	1.4850
CI lower M	0.1152	0.2080	0.1269	0.3594	0.5104	0.1964	0.3752	0.1759	0.2060	0.2577
CI upper F	0.3157	0.3749	1.0432	0.4915	0.9833	0.5800	0.8868	0.9260	0.7458	1.1344
CI lower F	-0.0540	-0.0290	0.0682	-0.0047	0.1890	-0.0219	0.0745	0.0688	-0.0287	0.1677

Appendix III cont.

South Australian age-standardised incidence and mortality rates (per 100,000 per annum) for oral cancer, 1977-1996
Presented by sex and site showing 95% confidence limits

Salivary Gland Cancer (142 ICD-9) – Mortality

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
World standard M	0.2667	0.4147	0.7987	0.5859	0.4936	0.6266	1.0980	0.4802	0.4657	0.3844
World standard F	0.1387	0.3722	0.0746	0.0000	0.0581	0.3029	0.2051	0.0000	0.1736	0.3336
CI upper M	0.6378	0.8865	1.4407	1.1656	0.9820	1.1768	1.8321	0.9574	0.9304	0.8236
CI lower M	-0.1045	-0.0571	0.1567	0.0063	0.0052	0.0764	0.3639	0.0030	0.0009	-0.0548
CI upper F	0.4104	0.7959	0.2209	0.0000	0.1718	0.6563	0.5179	0.0000	0.5138	0.6720
CI lower F	-0.1331	-0.0515	-0.0717	0.0000	-0.0557	-0.0504	-0.1077	0.0000	-0.1666	-0.0048

Salivary Gland Cancer (142 ICD-9) - Mortality

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
World standard M	0.2914	0.3318	0.0000	0.0837	0.2198	0.2493	0.4993	0.2885	0.5802	0.6774
World standard F	0.0000	0.0447	0.1167	0.0781	0.0391	0.0000	0.1991	0.0352	0.1742	0.0325
CI upper M	0.6260	0.7093	0.0000	0.2478	0.5360	0.5355	0.9451	0.5719	1.0675	1.1791
CI lower M	-0.0433	-0.0458	0.0000	-0.0804	-0.0963	-0.0368	0.0534	0.0052	0.0928	0.1757
CI upper F	0.0000	0.1322	0.3453	0.2313	0.1159	0.0000	0.4657	0.1043	0.4429	0.0963
CI lower F	0.0000	-0.0429	-0.1120	-0.0750	-0.0376	0.0000	-0.0675	-0.0338	-0.0945	-0.0312

Appendix IV

Example of Poisson regression analysis carried out to assess time trends in incidence and mortality rates. Shows calculation for lip cancer (140 ICD-9) incidence in South Australian males.

Lip cancer incidence: males

The LOGISTIC Procedure

Data Set: WORK.LIP
Response Variable (Events): LCASE
Response Variable (Trials): POP
Number of Observations: 257
Link Function: Logit

Response Profile

Ordered Value	Binary Outcome	Count
1	EVENT	2095
2	NO EVENT	9332603

WARNING: 83 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	39395.659	38017.956	.
SC	39409.708	38060.104	.
-2 LOG L	39393.659	38011.956	1381.703 with 2 DF (p=0.0001)
Score	.	.	1448.014 with 2 DF (p=0.0001)

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-38.3779	7.6996	24.8441	0.0001	.	.
AGE	1	0.2333	0.00654	1274.5972	0.0001	0.436700	1.263
YEAR	1	0.0138	0.00387	12.7032	0.0004	0.042568	1.014

NOTE: Measures of association between the observed and predicted values were not calculated because the predicted probabilities are indistinguishable when they are classified into intervals of length 0.002 .

Appendix IV cont.

Example of Poisson regression analysis carried out to assess time trends in incidence and mortality rates. Shows calculation for lip cancer (140 ICD-9) incidence in South Australian males.

Lip cancer incidence: males

The LOGISTIC Procedure

Data Set: WORK.LIP
Response Variable (Events): LCASE
Response Variable (Trials): POP
Number of Observations: 257
Link Function: Logit

Response Profile

Ordered Value	Binary Outcome	Count
1	EVENT	2095
2	NO EVENT	9332603

WARNING: 83 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	39395.659	38005.961	.
SC	39409.708	38104.305	.
-2 LOG L	39393.659	37991.961	1401.698 with 6 DF (p=0.0001)
Score	.	.	1474.102 with 6 DF (p=0.0001)

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-11.2251	0.1014	12261.1068	0.0001	.	.
AGE	1	0.2339	0.00653	1284.0672	0.0001	0.437863	1.264
YR2	1	0.3183	0.0805	15.6509	0.0001	0.068963	1.375
YR3	1	0.3684	0.0831	19.6550	0.0001	0.072902	1.445
YR4	1	0.2845	0.0831	11.7046	0.0006	0.059292	1.329
YR5	1	0.4239	0.0802	27.9178	0.0001	0.086841	1.528
YR6	1	0.2812	0.0818	11.8082	0.0006	0.057361	1.325

NOTE: Measures of association between the observed and predicted values were not calculated because the predicted probabilities are indistinguishable when they are classified into intervals of length 0.002 .

Appendix IV cont.

Example of Poisson regression analysis carried out to assess time trends in incidence and mortality rates. Shows calculation for lip cancer (140 ICD-9) incidence in South Australian males.

Lip cancer incidence: males

The LOGISTIC Procedure

Data Set: WORK.LIP
Response Variable (Events): LCASE
Response Variable (Trials): POP
Number of Observations: 257
Link Function: Logit

Response Profile

Ordered Value	Binary Outcome	Count
1	EVENT	2095
2	NO EVENT	9332603

WARNING: 83 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	39395.659	38005.961	.
SC	39409.708	38104.305	.
-2 LOG L	39393.659	37991.961	1401.698 with 6 DF (p=0.0001)
Score	.	.	1474.102 with 6 DF (p=0.0001)

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-10.9439	0.0969	12751.3718	0.0001	.	.
AGE	1	0.2339	0.00653	1284.0672	0.0001	0.437863	1.264
YR1	1	-0.2812	0.0818	11.8082	0.0006	-0.056184	0.755
YR2	1	0.0371	0.0726	0.2608	0.6096	0.008031	1.038
YR3	1	0.0871	0.0755	1.3332	0.2482	0.017245	1.091
YR4	1	0.00322	0.0755	0.0018	0.9660	0.000671	1.003
YR5	1	0.1427	0.0723	3.8967	0.0484	0.029228	1.153

NOTE: Measures of association between the observed and predicted values were not calculated because the predicted probabilities are indistinguishable when they are classified into intervals of length 0.002 .

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