CHAPTER 5: ORAL HEALTH HUMAN RESOURCES NEEDS FOR SOUTH AFRICAN CHILDREN

5.1 Introduction

The four approaches to human resources planning (human resources to population ratios, health needs, health demands and service targets) (Hall, 1978) and the WHO/FDI human resources planning model (World Health Organization/Fédération Dentaire Internationale, 1989) were reviewed in Chapter 2.

This chapter describes two models to calculate oral health human resources required for the delivery of the minimum package of oral care to 4- to 15-year-old children. These models are:

- The WHO/FDI human resources planning model (World Health Organization/Fédération Dentaire Internationale, 1989); and
- A "Service Targets Method" model.

For the purpose of this study both approaches assume that the public oral health services would not be responsible for delivering the minimum package of oral care to children older than fifteen.

5.2 World Health Organization/Fédération Dentaire Internationale human resources planning model

This model is based on the needs and demands of a population. It places a much bigger emphasis on the prevention and control of disease, maintenance of health and high quality restorative care and also provides for modifying factors. The WHO/FDI model translates need into FTE of oral health human resources required to provide a calculated level of care.

The WHO/FDI model was used in two previous South African studies to determine human resources needed for delivering primary preventive services (Booyens, 1994) and to develop a human resources plan for oral health care for the province of KwaZulu-Natal (Kissoon-Singh, 2001). The results of both these studies were reviewed in Chapter 2.

The WHO/FDI model calculates human resources for the 0- to 14-, 15- to 29-, 30- to 64- and 65- to 79-year-old age cohorts. Based on the assumption that the public oral health services would not be responsible for delivering the minimum package of oral care to children older than fifteen, the WHO/FDI model was adapted to calculate oral health human resources requirements for the 4- to 15-year-old age cohort only.

The input variables to calculate human resources required with the WHO/FDI model to deliver the minimum package or oral care to the 4- to 5- (primary dentition) and 6- to 15-year-old (mixed/permanent dentition) age cohorts are presented in Table 43. Each variable has been allocated a unique number (in a square bracket) which indicates where it is used in the different formulas. Variables have been grouped as follows:

(A) Restorative Care, arresting care and extractions
(B) Treatment time requirements
(C) Human resources requirements

All predetermined values used in this model are based on those for a country with stable caries levels (World Health Organization/Fédération Dentaire Internationale, 1989).

Microsoft Excel software was used to computerise the WHO/FDI model. An example of the model applied on a national level is presented in Annexure 4.

Table 43: The WHO/FDI model to calculate human resources required to deliver the minimum package of oral care (World Health Organization/Fédération Dentaire Internationale, 1989)

Variable	Formula
(A) RESTORATIVE CARE, ARRESTING CARE AND EXTRACTIONS	
[1] Number of age intervals	
[2] Predicted dmft or DMFT	
[3] Predicted dt or DT	
[4] Predicted mt or MT	
[5] Predicted ft or FT	
[6] Restoration fraction	
[7] New fillings : Teeth (NFT)	[6] x [2]
[8] Mean replacement period in years for a restoration	
[9] Replacement fillings : Teeth (RFT)	([1] x [7]) / (2 x [8])
[10] Ratio Surfaces / Teeth	
[11] Sealants, arresting care and remineralisation	(1 - [6]) x [2]
[12] New fillings : Surfaces (NFS)	[7] x [10]
[13] Replacement fillings : Surfaces (RFS)	[9] x [10]
[14] Extraction	[4]
(B) TREATMENT TIME REQUIREMENTS	
[15] Number of Group Preventive Care sessions	
[16] Time per Group Preventive Care session	
[17] Group Preventive Care (minutes)	[15] x [16]
[18] Number of Individual Preventive Care sessions	
[19] Time per Individual Preventive Care session	
[20] Individual Preventive Care (minutes)	[18] x [19]
[21] Time per fissure sealant	
[22] Arresting Care (minutes)	[11] x [21]
[23] Mean number of sextants in need of scaling	
[24] Time per scaling per sextant	
[25] Number of scaling sessions	
[26] Periodontal Care (prophylaxis only) (minutes)	[23] x [24] x [25]
[27] % in need of Surgical Care	
[28] Time for Surgical Care	
[29] Surgical Care (minutes)	[27] / 100 x [28]
[30] Time per restoration (new or replacement)	
[31] Restorative Care for new fillings (NFS) (minutes)	[12] x [30]
[32] Restorative Care for replacement fillings (RFS) (minutes)	[13] x [30]
[33] Time per extraction	
[34] Extraction (minutes)	[14] x [33]
[35] Total minutes of need per cohort	[17]+[20]+[22]+[26]+[29]+[31]+[32]+[34]
Total minutes of need per year:	
[36] For total human resources	[35] / [1]
[37] For Oral Hygienists	([17]+[20]+[22]+[26]) / [1]
[38] For Dental Therapists/Dentists	([29]+[31]+[32]+[34]) / [1]
[39] % Demand (utilization)	
Minutes of demand per year:	
[40] For total human resources	[36] x [39] /100
[41] For Oral Hygienists	[37] x [39] /100
[42] For Dental Therapists/Dentists	[38] x [39] /100

Table 43: (continued)

Variable	Formula
(C) HUMAN RESOURCES CALCULATIONS	
[43] Working year (hours)	
[44] Working year (minutes)	[43] x 60
Human resources : population ratio:	
[45] For total human resources	[44] / [40]
[46] For Oral Hygienists	[44] / [41]
[47] For Dental Therapists/Dentists	[44] / [42]
[48] Population size	
Number of human resources required:	
[49] Total human resources	[48] / [45]
[50] Oral Hygienists	[48] / [46]
[51] Dental Therapists/Dentists	[48] / [47]
[52] Dentists	[51] / 6
(Ratio 1 Dentist : 5 Dental Therapists)	
[53] Dental Therapists	[51] / 6 x 5
(Ratio 1 Dentist : 5 Dental Therapists)	
[54] Dental Assistants	[51] x 1.5
(Ratio 1 Dental Therapist/Dentist : 1.5 Dental Assistants)	

5.2.1 Restorative care, arresting care and extractions (Variable Group (A))

a) Number of age intervals (Variable [1])

Calculations were done for the 4- to 5- and the 6- to 15-year-old age cohorts. The number of age intervals for each cohort are:

- **Age 4 to 5:** Two (4-5 and 5-5.99)
- **Age 6 to 15:** Ten (6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-13, 13-14, 14-15 and 15-15.99)

b) Predicted caries prevalence values (Variables [2] to [5])

The WHO/FDI model requires DMFT caries index data as treatment need information. Caries prevalence data for 4- to 5- (dmft) and 15-year-old children (DMFT) from the 1999-2002 NCOHS (Department of Health, 2003b) were used in the calculations. These are summarised in Table 44. The mean national values were used for 4- to 5-year-olds in the Northern Cape as this age cohort was not included in the survey for that province.

Table 44: Caries prevalence of 4- to 5- and 15-year-old South African children: 1999-2002 NCOHS (Department of Health, 2003b)

Province	4- to 5-year-olds				15-year-olds			
	dmft (Var. [2])	dt (Var. [3])	mt (Var. [4])	ft (Var. [5])	DMFT (Var. [2])	DT (Var. [3])	MT (Var. [4])	FT (Var. [5])
National	2.44	1.95	0.35	0.16	1.86	1.34	0.29	0.23
Western Cape	4.81	3.66	1.04	0.10	3.99	2.65	0.92	0.42
Northern Cape	2.44	1.95	0.35	0.16	2.88	2.48	0.32	0.07
Eastern Cape	3.36	2.55	0.73	0.07	2.01	1.08	0.64	0.28
Free State	2.96	2.60	0.31	0.05	1.92	1.73	0.09	0.09
KwaZulu-Natal	2.52	2.30	0.19	0.03	1.87	1.57	0.22	0.08
Gauteng	1.96	1.06	0.20	0.66	1.81	1.04	0.11	0.65
North West	1.52	1.39	0.09	0.04	1.20	1.00	0.08	0.11
Mpumalanga	2.05	1.58	0.24	0.23	1.66	1.31	0.10	0.24
Limpopo	0.84	0.82	0.10	0.01	0.86	0.78	0.05	0.03

c) Restoration fraction (Variable [6])

This variable was predetermined and represents the fraction of the dmft/DMFT which can be saved through preventive procedures. The values used in this model are:

- **Age 4 to 5:** 0.5
- **Age 6 to 15:** 0.6

d) New fillings : Teeth (NFT) (Variable [7])

The NFT ratio was calculated by applying the formula:
Restoration fraction x Predicted dmft or DMFT

e) Mean replacement period in years for a restoration (Variable [8])

This variable was predetermined and a value of fifteen years was used in this model.

f) Replacement fillings : Teeth (RFT) (Variable [9])

The RFT ratio was calculated by applying the formula:
(Age intervals x NFT) / (2 x Mean replacement period in years for a restoration)

g) Ratio of surfaces / Teeth (Variable [10])

This variable was predetermined and a value of 1.5 was used in this model.

h) Sealants, arresting care and remineralisation (Variable [11])

This variable was calculated by applying the formula:
(1 – Restoration fraction) x Predicted dmft or DMFT

i) New fillings : Surfaces (NFS) (Variable [12])

The NFS ratio was calculated by applying the formula:
NFT x Ratio of surfaces / Teeth

j) Replacement fillings : Surfaces (RFS) (Variable [13])

The RFS ratio was calculated by applying the formula:
RFT x Ratio of surfaces / Teeth

k) Extraction (Variable [14])

This variable is represented by the predicted mt or MT (Variable [4]).

5.2.2 Treatment time requirements (Variable Group (B))

a) Group Preventive Care (Variables [15] to [17])

The number of group preventive care sessions as well as the time per session was predetermined. A single group preventive session in each of the 4- to 5- and 6- to 15-year-old cohorts (Variable [15]) of fifteen minutes duration (Variable [16]) was used in this model.

The time required for group preventive care (Variable [17]) was calculated by applying the formula:
Number of Group Preventive Care sessions x Time per Group Preventive Care session

b) Individual Preventive Care (Variables [18] to [20])

The number of individual preventive care sessions as well as the time per session was predetermined. For this study no individual preventive care was included for the 4- to 5-year-old cohort. Four sessions (Variable [18]) of fifteen minutes each (Variable [19]) over the duration of the 6- to 15-year-old cohort (10 years) were used in this model.

The time required for individual preventive care (Variable [20]) was calculated by applying the formula:
Number of Individual Preventive Care sessions x Time per Individual Preventive Care session

c) Arresting care (Variables [21] and [22])

Variable [21] was predetermined and a value of 5 minutes required per fissure sealant was used in this model.

Arresting care (Variable [22]) was calculated by applying the formula:
Sealants, arresting care and remineralisation variable x Time per fissure sealant

d) Periodontal care (Variables [23] to [26])

Severity of periodontal disease for 15-year-old children in South Africa as determined in the 1999-2002 NCOHS (Department of Health, 2003b) was used in the calculations for periodontal care for the 6- to 15-year-old cohort only as it was assumed that no periodontal care would be required for the 4- to 5-year-old cohort. The mean number of sextants with bleeding and calculus are presented in Table 45. The mean national values were used for Gauteng as periodontal disease was not included in the survey for this province.

In this model the sum of the mean number of sextants with bleeding and calculus were regarded as being in need of a prophylaxis treatment (Variable [23]).

This study does recognise the limitations of the use of CPI data in human resources planning as reported in the literature (Manji and Sheiham, 1986; Page and Morrison, 1994).

Table 45: Mean number of sextants with bleeding and calculus in 15-year-old South African children (Department of Health, 2003b)

Province	Mean number of sextants		
	Bleeding	Calculus	Total sextants in need of scaling
Weighted national mean	1.14	2.17	3.31
Western Cape	1.43	1.84	3.27
Northern Cape	1.45	0.85	2.3
Eastern Cape	0.26	2.62	2.88
Free State	0.99	2.96	3.95
KwaZulu-Natal	1.34	2.23	3.57
Gauteng	1.14	2.17	3.31
North West	1.1	1.47	2.57
Mpumalanga	0.75	1.22	1.97
Limpopo	1.98	2.43	4.41

Variables [24] and [25] were predetermined and values of two sessions of periodontal care over the duration of the 6- tot 15-year-old cohort and five minutes required for each sextant in need of scaling were used in this model.

Periodontal care (prophylaxis only) (Variable [26]) was calculated by applying the formula:
Mean number of sextants in need of scaling x Time per scaling per sextant x Number of scaling sessions

e) Surgical care (Variables [27] to [29])

It was assumed that 60 minutes would be required to cover surgical care for trauma, impaction and other oral surgery (Variable [28]) over the duration of

each of the 4- to 5- and 6- to 15-year-old age cohorts (World Health Organization/Fédération Dentaire Internationale, 1989).

The following values were assumed for the percentage of children in need of surgical care (Variable [27]):

- **Age 4 to 5:** 1%
- **Age 6 to 15:** 10%

Surgical care (Variable [29]) was calculated by applying the formula:
% in need of Surgical Care x Time for Surgical Care

f) Restorative care for new and replacement fillings (Variables [30] to [32])

The WHO/FDI model assumes that fifteen minutes are required for either a new or a replacement restoration (Variable [30]). The following formulas were applied:

- **Restorative care for new fillings (NFS) (Variable [31]):**
  NFS x Time per restoration

- **Restorative care for replacement fillings (RFS) (Variable [32]):**
  RFS x Time per restoration

g) Extractions (Variables [33] and [34])

The WHO/FDI model assumes that 7.5 minutes are required per extraction (Variable [33]). Time for extractions was calculated by applying the formula:
Extraction variable x Time per extraction

h) Total minutes of need per cohort (Variable [35])

This variable was calculated by adding the time required for preventive (group and individual), arresting, periodontal, surgical and restorative care as well as extractions.

i) Total minutes of need per year (Variables [36] to [38])

This variable was calculated by applying the formula:

Total minutes of need per cohort / Age intervals

By assuming that the oral hygienist would be responsible for delivering the preventive, arresting and periodontal care and the dental therapist/dentist the surgical care, restorative care and extractions, total minutes of need per year were calculated separately for each of the total human resources (Variable [36]), oral hygienists (Variable [37]) and dental therapists/dentists (Variable [38]) by applying the formula above for those procedures for which the oral hygienist and dental therapist/dentist are responsible.

j) Minutes of demand per year (Variables [39] and [40])

Table 46 provides information on the utilization of oral health services by South African adults aged 20 to 64 as determined in the 1988/89 NOHS (Department of Health, 1994). A weighted national mean value was calculated from this data using the 2006 South African mid-year population estimates (Statistics South Africa, 2006). A weighted mean service utilization value of 25.7% for those having visited a dentist/dental clinic within the last 12 months was used for both the 4- to 5- and 6- to 15-year-old cohorts (Variable [39]).

Table 46: Utilization of services based on time elapsed since previous visit to a dentist or dental clinic for the South African adult population (Department of Health, 1994)

Time elapsed since last visit	Percentage utilization of services by population group (% of population)				
	Asian (2.46%)	Black (79.47%)	Coloured (8.86%)	White (9.21%)	Weighted national mean
Within 12 months	31.5	21.5	26.7	59.9	**25.7**
> 1 year ago	49.7	48.9	64.9	37.4	49.3
Do not know	5.3	2.7	4.5	2.2	2.9
Never	13.5	26.9	3.9	0.5	22.1

Minutes of demand per year were calculated for the each of the total human resources (Variable [40]), oral hygienists (Variable [41]) and dental therapists/dentists (Variable [42]) by applying the formula:
Total minutes of need per year x % Demand

5.2.3 Human resources calculations (Variable Group (C))

a) Working year (Variables [43] and [44])

For the purpose of this model a working year (Variable [43]) was considered as 40 hours per week for 44 weeks (1,760 hours).

In this model this value was converted to minutes (Variable [44]) for calculating the human resources required.

b) Human resources to population ratio (Variables [45] to [47])

This variable was calculated for the each of the total human resources (Variable [45]), oral hygienists (Variable [46]) and dental therapists/dentists (Variable [47]) by applying the formula:
Working year in minutes / Minutes of demand per year

c) Population size (Variable [48])

This variable was calculated from the 2006 South African mid-year population estimates (Statistics South Africa, 2006). Table 47 presents the values used in this model.

d) Number of human resources required (Variables [49] to [54])

The number of human resources required was calculated for the each of the total human resources (Variable [49]), oral hygienists (Variable [50]) and dental therapists/dentists (Variable [51]) by applying the formula:
Population size / Human resources : population ratio

The ratio of dental therapists to dentists of 5:1 and dental therapists/dentists to dental assistants of 1:1.5 as described in Table 12 (p 63) (Department of Health, 1999) were applied to the results to separately calculate the number of dentists (Variable [52]), dental therapists (Variable [53]), and dental assistants (Variable [54]) required.

Table 47: 2006 South African mid-year population estimates for the 4- to 5- and 6- to 15-year-old age cohorts (Statistics South Africa, 2006)

Province	Total population	4- to 5-year-olds		6- to 15-year-olds		4- to 15-year-olds	
		n	%	n	%	n	%
National	47,390,800	2,035,320	4.29	10,087,080	21.28	12,122,400	25.57
Western Cape	4,745,500	182,980	3.86	869,340	18.32	1,052,320	22.18
Northern Cape	910,500	38,600	4.24	186,540	20.49	225,140	24.73
Eastern Cape	7,051,500	312,260	4.43	1,700,100	24.11	2,012,360	28.54
Free State	2,958,800	119,940	4.05	607,120	20.52	727,060	24.57
KwaZulu-Natal	9,731,800	440,360	4.52	2,235,140	22.97	2,675,500	27.49
Gauteng	9,211,200	348,300	3.78	1,472,640	15.99	1,820,940	19.77
North West	3,858,200	167,900	4.35	798,240	20.69	966,140	25.04
Mpumalanga	3,252,500	151,180	4.65	751,980	23.12	903,160	27.77
Limpopo	5,670,800	273,800	4.83	1,465,980	25.85	1,739,780	30.68

5.2.4 Impact of the implementation of water fluoridation

Estimated caries reductions as a result of the implementation of water fluoridation of 10%, 30% and 50%, were applied to the dmft/DMFT values (Variables [2] to [5]) to indicate the impact that this would have on the required human resources.

Results of the human resources required to deliver the minimum package of oral care to the 4- to 5- and 6- to 15-year-old cohorts with and without the impact of water fluoridation as calculated with the WHO/FDI model are presented in Section 5.4 (p 149).

5.3 A “Service Targets Method” model to calculate human resources

This approach involves the setting of targets for the production and delivery of specific health services followed by converting these into human resources

requirements by means of staffing and productivity standards. This method attempts to strike a balance between needs and wants of the population, available technology and what can be delivered (Hall, 1978).

Based on need and demand the service target for the model described in this section is to deliver the minimum package of oral care to 4- to 15-year-old children with appropriate oral health human resources where the oral hygienist would be responsible for delivering the group prevention, periodontal care (prophylaxis only), topical fluoride application and fissure sealants and the dental therapist/dentist the restorative care and extractions.

Similar to the approach used for the WHO/FDI model, for the purpose of this study, this model also assumes that the public oral health services would not be held responsible for delivering the minimum package of oral care to children older than fifteen.

The calculation of oral health human resources requirements with this model consisted of three steps:

1. Convert treatment need to time required to complete treatment;
2. Convert time required to complete treatment need to demand time to complete treatment; and
3. Convert demand time to complete treatment to human resources required.

Table 48 presents the input variables to calculate the human resources required to deliver the minimum package of oral care to the 4- to 15-year-old cohort with a “Service Target Method” model. Each variable has been allocated a unique number (in a square bracket) which indicates where it is used in the different formulas.

Microsoft Excel software was used to computerise this model. An example of the model applied to the 4- to 15-year-old age cohort is presented in Annexure 5.

Table 48: A "Service Targets Method" model to calculate human resources needed to deliver the minimum package of oral care

Variable	Formula
(A) Minutes of need	
[1] Population size	
[2] Treatment need	
[3] Treatment time per procedure	
[4] Time to complete each treatment need type	[1] x [2] x [3]
[5] Total time to complete treatment need	
[6] Per capita time to complete treatment need	[5] / [1]
[7] % of total time for each treatment need type	[4] / [5] x 100
[8] Per capita time of each treatment need type	[6] x [7] / 100
(B) Minutes of demand	
[9] % Demand (utilization)	
[10] Minutes of demand per person per year	[6] x [9] / 100
(C) Human resources calculations	
[11] Working year (hours)	
[12] Working year (minutes)	[11] x 60 minutes
[13] Human resource : population ratio	[12] / [10]
[14] Number of human resources required	[1] / [13]

5.3.1 Minutes of need (Variable Group (A))

a) Population size (Variable [1])

The 2006 South African mid-year population estimates by age and sex (national and per province) were used in this model (Statistics South Africa, 2006). Since these population estimates are presented in five year age intervals, the mean values for each interval were used to calculate the population estimates for the 4- to 15-year-old cohort. A population estimate for the 6- to 15-year-old age cohort was used to calculate the human resources for prophylaxis since this procedure was not included in this model for the 4- to 5-year-olds. Population size values used in this model are presented in Table 47 (p 142).

b) Treatment need (Variable [2])

Percentage treatment need and mean number of teeth in need of treatment as reported in Chapter 4 (Table 31, p 110 and Table 32, p 111) for 4- to 5-, 6-, 12- and 15-year-olds were used to calculate a mean weighted value for the 4- to 15-year-old cohort on a national as well as a provincial level for each of the

nine South African provinces. The mean national value was used for Gauteng and Limpopo as survey data for these two provinces were not available.

Similar to the model described in Chapter 4 to calculate the per capita cost to deliver the minimum package or oral care as well as the WHO/FDI human resources model described in a previous section of this chapter, it was assumed that no periodontal care would be required for the 4- to 5-year-old cohort. Data for 15-year-old children in South Africa as determined in the 1999-2002 NCOHS (Department of Health, 2003b) and reported as the percentage of sextants (prevalence) and the mean number of sextants (severity) with the highest score being either healthy or bleeding was used in this model for the 6- to 15-year-old age cohort (See Table 33, p 114). The mean national values were used for Gauteng as periodontal disease was not included in the survey for 15-year-olds for this province.

An oral examination and bitewing radiographs were excluded from the calculations in this model as these procedures were not included in the WHO/FDI model either. The mean weighted treatment need values used in this model are presented in Table 49.

Table 49: Treatment need as a percentage of the population or mean number of teeth/sextants for the 4- to 15-year-old age cohort

Province	Prophylaxis	Topical fluoride application	Fissure sealant	1 surface restoration	>1 surface restoration	Extraction
	Mean no. of sextants	% of population	Mean no. of teeth	Mean no. of teeth	Mean no. of teeth	Mean no. of teeth
National	3.31	5.39	0.80	0.39	0.20	0.29
Western Cape	3.27	2.46	1.80	0.56	0.36	0.50
Northern Cape	2.3	2.36	0.31	0.93	0.81	0.77
Eastern Cape	2.88	6.66	0.07	0.29	0.14	0.37
Free State	3.95	5.21	1.13	0.54	0.13	0.28
KwaZulu-Natal	3.57	6.32	0.94	0.29	0.18	0.26
Gauteng	3.31	5.39	0.80	0.39	0.20	0.29
North West	2.57	5.79	0.29	0.25	0.11	0.07
Mpumalanga	1.97	5.24	0.05	0.48	0.24	0.33
Limpopo	4.41	5.39	0.80	0.39	0.20	0.29

c) Treatment time per procedure (Variable [3])

Treatment times used for this model were based on those of the WHO/FDI human resources model, except for topical fluoride application. These are:

- **Group prevention:** Four sessions of fifteen minutes each over twelve age intervals between the ages of 4 to 15
- **Prophylaxis:** Two prophylaxis treatment sessions for the 6- to 15-year-old cohort based on five minutes per sextant in need of a scaling over ten age intervals
- **Topical fluoride application:** Three fluoride applications of ten minutes each at ages 6, 12 and 15 over twelve age intervals. These ages were chosen to coincide with the eruption of the first and second permanent molars at a stage when mineralisation of the enamel has not been fully completed. A final topical fluoride application is provided at age fifteen, the last age for which it is assumed the minimum package of oral care would be provided.
- **Fissure sealants:** Five minutes per sealant
- **Restorations (one or more than one surface):** Fifteen minutes per restoration
- **Extractions:** 7.5 minutes per extraction

The treatment times used in this model are summarised in Table 50.

Table 50: Treatment times used in the "Service Targets Method" model

Procedure	Estimated time per year (minutes)
Group prevention	4 sessions x 15 minutes each / 12 age intervals = 5 minutes per year
Prophylaxis	2 sessions x 5 minutes per sextant / 10 age intervals = 1 minute per year
Topical fluoride application	3 applications x 10 minutes each / 12 age intervals = 2.5 minutes per year
Fissure sealant	5 minutes per sealant
1 surface restoration	15 minutes per restoration
More than 1 surface restoration	15 minutes per restoration
Extraction	7.5 minutes per extraction

d) Time to complete each treatment need type (Variable [4])

For each of the treatment need types the time to complete treatment for the specific procedure was calculated by applying the formula:

Population size x Treatment need x Treatment time per procedure

e) Total time to complete treatment need (Variable [5])

Total time to complete treatment need was calculated by adding all times required to complete each of the treatment need types which are part of the minimum package or oral care.

f) Per capita time to complete treatment need (Variable [6])

This variable was calculated by applying the formula:

Total time to complete treatment need / Population size

g) Percentage of total time for each treatment need type (Variable [7])

The time to complete each treatment need type was expressed as a percentage of the total time to address treatment need by applying the formula:

Time to complete each treatment need type / Total time to complete treatment need x 100

h) Per capita time of each treatment need type (Variable [8])

The time for each treatment need type was converted to a per capita time by applying the formula:

Per capita time to complete treatment need x % of total time for each treatment need type

5.3.2 Minutes of demand (Variable Group (B))

Similar to the WHO/FDI model a mean weighted service utilization value of 25.7% (Variable [9]) for those having visited a dentist or dental clinic within the last 12 months (see Table 46, p 140) was used in this model.

Minutes of demand per person per year (Variable [10]) was calculated by applying the formula:
Per capita time to complete treatment need x % Demand

5.3.3 Human resources calculations (Variable Group (C))

a) Working year (Variables [11] and [12])

For the purpose of this study a working year (Variable [11]) was considered as 40 hours per week for 44 weeks (1,760 hours).

This value was converted to minutes (Variable [12]) for calculating the human resources required with this model.

b) Human resources to population ratio (Variable [13])

This variable was calculated by applying the formula:
Working year in minutes / Minutes of demand per person per year

c) Number of human resources required (Variable [12])

This variable was calculated by applying the formula:
Population size / Human resources : population ratio

The number of required oral hygienists was calculated based on the minutes of demand per person per year to deliver prevention, prophylaxis, fissure sealants and fluoride applications. The number of required dental therapists/dentists was calculated based on the minutes of demand per person per year to deliver restorations and extractions.

Similar to the WHO/FDI model the ratios of dental therapists to dentists (5:1) and dental therapists/dentists to dental assistants (1:1.5) as described in

Table 12 (p 63) (Department of Health, 1999) were applied to the results to separately determine the number of dental therapists, dentists and dental assistants required.

5.3.4 Impact of the implementation of water fluoridation

Estimated caries reductions as a result of the implementation of water fluoridation of 10%, 30% and 50%, were applied to the treatment need values to indicate the impact that this would have on the required human resources to deliver the minimum package of oral care.

Results of the human resources required for the 4- to 15-year-old cohort with and without the impact of water fluoridation as calculated with the "Service Targets Method" model are presented in the next section.

5.4 Results

5.4.1 Background information

For both the WHO/FDI and "Service Targets Method" models results are presented for the 4- to 15-year-old age cohort using oral health status and treatment need data for dental caries and periodontal disease (bleeding and calculus only) from the 1999-2002 NCOHS (Department of Health, 2003b) combined with a mean weighted demand/utilization of services of 25.7% (See Table 46, p 140).

Based on anticipated caries reductions as a result of the implementation of water fluoridation of 10%, 30% and 50%, caries prevalence values for the WHO/FDI model and treatment need for dental caries values for the "Service Targets Method" model were adjusted accordingly to indicate the impact that this would have on the required human resources to deliver the minimum package of care.

For both models the total number of human resources required is indicated on a national as well as a provincial level. It was assumed that the oral hygienist would be responsible for delivering the group prevention, prophylaxis, topical fluoride application and fissure sealants and the dental therapist/dentist for the restorative care and extractions.

5.4.2 Total human resources

Table 51 presents the human resources required as calculated with the two models without the introduction of water fluoridation as well as assuming a 10%, 30% or 50% reduction in caries prevalence after its introduction. Please note that dental assistants are not included in the total human resources required column.

In general on both the national and all provincial levels the number of human resources required as calculated with the WHO/FDI model was less than calculated with the “Service Targets Method” model.

Table 52 presents the difference between the calculations for the two models for the total human resources requirements to deliver the minimum package of care.

Figure 11 and Figure 12 present the required human resources on a national level without water fluoridation and with an estimated caries reduction of 10%, 30% and 50% after its introduction as calculated with the WHO/FDI and “Service Targets Method” models.

Table 51: Summary of human resources requirements for 4- to 15-year-old South African children calculated with the WHO/FDI and "Service Targets Method" models

Estimated caries reduction	Total human resources (excl. Dental Assistants)		Oral Hygienists		Dental Therapists/ Dentists		Dentists		Dental Therapists		Dental Assistants	
	WHO/ FDI	STM	WHO/ FDI	STM	WHO/ FDI	STM	WHO/ FDI	STM	WHO/ FDI	STM	WHO/ FDI	STM
National												
No water fluoridation	510	679	327	352	183	327	31	54	153	272	275	490
10%	491	634	325	339	166	294	28	49	139	245	250	441
30%	453	544	320	315	133	229	22	38	111	191	200	343
50%	415	454	315	290	100	163	17	27	83	136	149	245
Western Cape												
No water fluoridation	63	88	31	43	33	45	5	8	27	38	49	68
10%	60	81	30	41	30	41	5	7	25	34	44	61
30%	53	68	29	36	23	32	4	5	19	26	35	48
50%	45	54	28	31	17	23	3	4	14	19	26	34
Northern Cape												
No water fluoridation	10	22	6	5	4	17	1	3	4	15	6	26
10%	10	20	6	5	4	16	1	3	3	13	6	24
30%	9	17	6	4	3	12	1	2	3	10	5	18
50%	8	13	5	4	2	9	0	1	2	7	3	13
Eastern Cape												
No water fluoridation	91	84	54	39	37	45	6	7	31	37	56	67
10%	87	79	53	39	34	40	6	7	28	34	51	60
30%	79	70	52	38	27	31	4	5	22	26	40	47
50%	71	60	51	38	20	22	3	4	17	19	30	34
Free State												
No water fluoridation	33	47	21	25	12	22	2	4	10	18	18	33
10%	31	44	21	24	11	20	2	3	9	16	16	29
30%	29	37	20	22	8	15	1	3	7	13	13	23
50%	26	31	20	20	6	11	1	2	5	9	10	16
KwaZulu-Natal												
No water fluoridation	114	142	74	84	40	59	7	10	33	49	60	88
10%	109	133	73	80	36	53	6	9	30	44	54	79
30%	101	115	72	74	29	41	5	7	24	34	43	62
50%	93	97	71	68	22	29	4	5	18	24	33	44

Note: STM = "Service Targets Method" model

Table 51: (continued)

Estimated caries reduction	Total human resources (excl. Dental Assistants)		Oral Hygienists		Dental Therapists/ Dentists		Dentists		Dental Therapists		Dental Assistants	
	WHO/ FDI	STM	WHO/ FDI	STM	WHO/ FDI	STM		WHO/ FDI	STM	WHO/ FDI	STM	WHO/ FDI
Gauteng												
No water fluoridation	74	102	49	52	25	49	4	8	21	41	38	74
10%	71	95	48	51	23	44	4	7	19	37	34	66
30%	66	81	48	47	18	34	3	6	15	29	27	52
50%	61	68	47	43	14	25	2	4	11	20	21	37
North West												
No water fluoridation	33	35	24	21	9	14	2	2	8	12	14	21
10%	32	33	24	20	9	13	1	2	7	11	13	19
30%	31	29	24	19	7	10	1	2	6	8	11	15
50%	29	26	23	19	5	7	1	1	4	6	8	11
Mpumalanga												
No water fluoridation	33	45	22	15	12	29	2	5	10	24	18	44
10%	32	42	22	15	11	26	2	4	9	22	16	40
30%	30	36	21	15	9	21	1	3	7	17	13	31
50%	27	30	21	15	6	15	1	2	5	12	10	22
Limpopo												
No water fluoridation	60	101	49	55	11	47	2	8	9	39	17	70
10%	59	95	49	53	10	42	2	7	9	35	16	63
30%	57	82	48	49	9	33	1	5	7	27	13	49
50%	55	69	48	46	7	23	1	4	6	20	10	35

Note: STM = “Service Targets Method” model

It is clear from Table 51 and both Figure 11 and Figure 12, irrespective of whether the WHO/FDI or the “Service Targets Method” model were used for the calculations, that oral hygienists represent the majority of oral health human resources required to deliver the minimum package of oral care to 4- to 15-year-old children.

Table 52: Difference between human resources requirements for 4- to 15-year-old South African children calculated with the WHO/FDI and "Service Targets Method" models

Estimated caries reduction	Total (excl. Dental Assistants)		Difference
	WHO/FDI	STM	
National			
No water fluoridation	510	679	169
10%	491	634	143
30%	453	544	91
50%	415	454	39
Western Cape			
No water fluoridation	63	88	25
10%	60	81	21
30%	53	68	15
50%	45	54	9
Northern Cape			
No water fluoridation	10	22	12
10%	10	20	10
30%	9	17	8
50%	8	13	5
Eastern Cape			
No water fluoridation	91	84	7
10%	87	79	8
30%	79	70	9
50%	71	60	11
Free State			
No water fluoridation	33	47	14
10%	31	44	13
30%	29	37	8
50%	26	31	5
KwaZulu-Natal			
No water fluoridation	114	142	28
10%	109	133	24
30%	101	115	14
50%	93	97	4
Gauteng			
No water fluoridation	74	102	28
10%	71	95	24
30%	66	81	15
50%	61	68	7
North West			
No water fluoridation	33	35	2
10%	32	33	1
30%	31	29	2
50%	29	26	3
Mpumalanga			
No water fluoridation	33	45	12
10%	32	42	10
30%	30	36	6
50%	27	30	3
Limpopo			
No water fluoridation	60	101	41
10%	59	95	36
30%	57	82	25
50%	55	69	14

Note: STM = "Service Targets Method" model

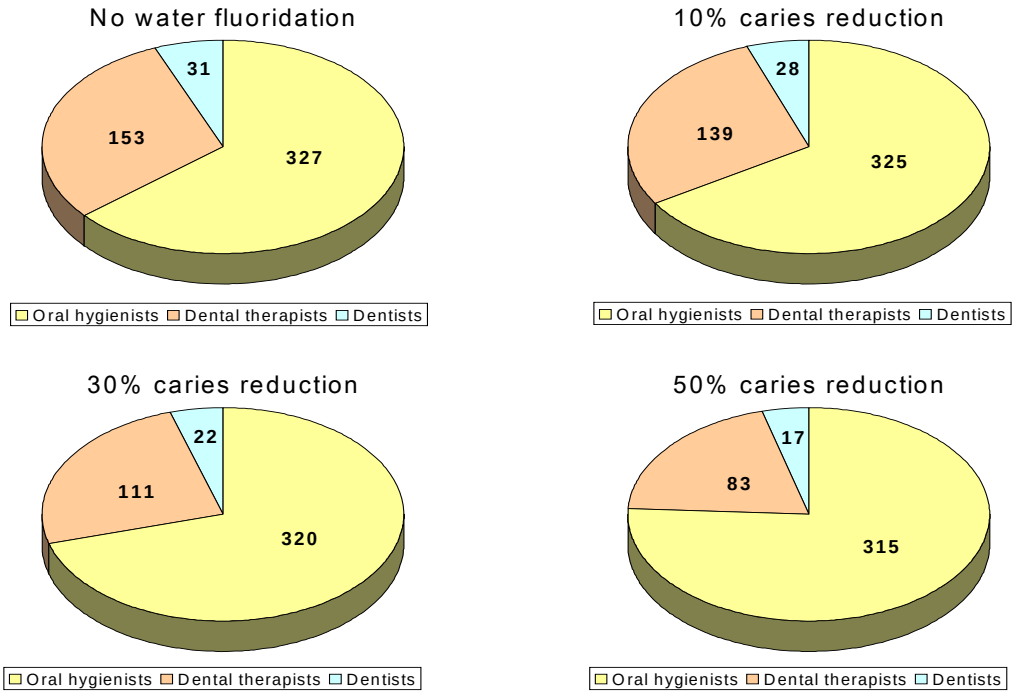

Figure 11: National human resources requirements calculated with the WHO/FDI model for delivering the minimum package of oral care to 4- to 15-year-old South African children

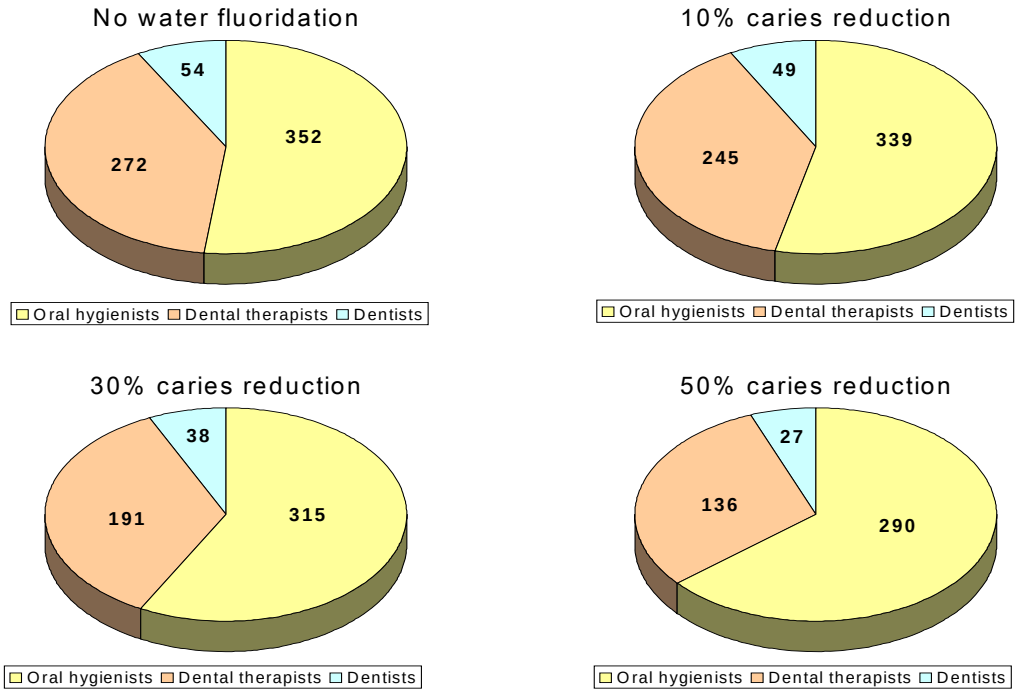

Figure 12: National human resources requirements calculated with the "Service Targets Method" model for delivering the minimum package of oral care to 4- to 15-year-old South African children

5.4.3 Oral hygienists

Table 53 presents the requirements for oral hygienists to deliver the minimum package of care as calculated with the WHO/FDI and "Service Targets Method" models. Requirements on a national and provincial level are also expressed as a percentage of the total number of human resources required.

For the WHO/FDI model, oral hygienists represent more than 50% of the total human resources required to deliver the minimum package of oral care to 4- to 15-year-olds. Although less oral hygienists are required when the "Service Targets Method" model was used, for the majority of provinces it still represents more than 50% of the total human resources required.

With both models, as the anticipated caries reduction due to the implementation of water fluoridation increases, the proportion of oral hygienists in relation to the need for dentists and dental therapists increases (see Table 54).

5.4.4 Dental therapists and dentists

Table 54 presents the requirements for dental therapists and dentists to deliver the minimum package of care as calculated with the WHO/FDI and "Service Targets Method" models. Requirements on a national and provincial level are also expressed as a percentage of the total number of human resources required.

Dental therapists represent approximately 30 to 40% and dentists less than 10% of the total human resources required to deliver the restorative care and extraction components of the minimum package of oral care to 4- to 15-year-old children.

Table 54 clearly illustrates the reduced need for both dental therapists and dentists as the anticipated level of caries reduction increases due to the introduction of water fluoridation.

Table 53: Requirements for oral hygienists for 4- to 15-year-old South African children using the WHO/FDI and "Service Targets Method" models

Estimated caries reduction	Total (excl Dental Assistants)		Oral Hygienists			
	WHO/FDI	STM	WHO/FDI		STM	
			n	% of total	n	% of total
National						
No water fluoridation	510	679	327	64.1	352	51.8
10%	491	634	325	66.2	339	53.5
30%	453	544	320	70.6	315	57.9
50%	415	454	315	75.9	290	63.9
Western Cape						
No water fluoridation	63	88	31	49.2	43	48.9
10%	60	81	30	50.0	41	50.6
30%	53	68	29	54.7	36	52.9
50%	45	54	28	62.2	31	57.4
Northern Cape						
No water fluoridation	10	22	6	60.0	5	22.7
10%	10	20	6	60.0	5	25.0
30%	9	17	6	66.7	4	23.5
50%	8	13	5	62.5	4	30.8
Eastern Cape						
No water fluoridation	91	84	54	59.3	39	46.4
10%	87	79	53	60.9	39	49.4
30%	79	70	52	65.8	38	54.3
50%	71	60	51	71.8	38	63.3
Free State						
No water fluoridation	33	47	21	63.6	25	53.2
10%	31	44	21	67.7	24	54.5
30%	29	37	20	69.0	22	59.5
50%	26	31	20	76.9	20	64.5
KwaZulu-Natal						
No water fluoridation	114	142	74	64.9	84	59.2
10%	109	133	73	67.0	80	60.2
30%	101	115	72	71.3	74	64.3
50%	93	97	71	76.3	68	70.1
Gauteng						
No water fluoridation	74	102	49	66.2	52	51.0
10%	71	95	48	67.6	51	53.7
30%	66	81	48	72.7	47	58.0
50%	61	68	47	77.0	43	63.2
North West						
No water fluoridation	33	35	24	72.7	21	60.0
10%	32	33	24	75.0	20	60.6
30%	31	29	24	77.4	19	65.5
50%	29	26	23	79.3	19	73.1
Mpumalanga						
No water fluoridation	33	45	22	66.7	15	33.3
10%	32	42	22	68.8	15	35.7
30%	30	36	21	70.0	15	41.7
50%	27	30	21	77.8	15	50.0
Limpopo						
No water fluoridation	60	101	49	81.7	55	54.5
10%	59	95	49	83.1	53	55.8
30%	57	82	48	84.2	49	59.8
50%	55	69	48	87.3	46	66.7

Note: STM = "Service Targets Method" model

Table 54: Requirements for dental therapists and dentists for 4- to 15-year-old South African children using the WHO/FDI and "Service Targets Method" models

Estimated caries reduction	Total (excl Dental Assistants)		Dental Therapists				Dentists			
			WHO/FDI		STM		WHO/FDI		STM	
	WHO/FDI	STM	n	% of total	n	% of total	n	% of total	n	% of total
National										
No water fluoridation	510	679	153	30.0	272	40.1	31	6.1	54	8.0
10%	491	634	139	28.3	245	38.6	28	5.7	49	7.7
30%	453	544	111	24.5	191	35.1	22	4.9	38	7.0
50%	415	454	83	20.0	136	30.0	17	4.1	27	5.9
Western Cape										
No water fluoridation	63	88	27	42.9	38	43.2	5	7.9	8	9.1
10%	60	81	25	41.7	34	42.0	5	8.3	7	8.6
30%	53	68	19	35.8	26	38.2	4	7.5	5	7.4
50%	45	54	14	31.1	19	35.2	3	6.7	4	7.4
Northern Cape										
No water fluoridation	10	22	4	40.0	15	68.2	1	10.0	3	13.6
10%	10	20	3	30.0	13	65.0	1	10.0	3	15.0
30%	9	17	3	33.3	10	58.8	1	11.1	2	11.8
50%	8	13	2	25.0	7	53.8	0	0.0	1	7.7
Eastern Cape										
No water fluoridation	91	84	31	34.1	37	44.0	6	6.6	7	8.3
10%	87	79	28	32.2	34	43.0	6	6.9	7	8.9
30%	79	70	22	27.8	26	37.1	4	5.1	5	7.1
50%	71	60	17	23.9	19	31.7	3	4.2	4	6.7
Free State										
No water fluoridation	33	47	10	30.3	18	38.3	2	6.1	4	8.5
10%	31	44	9	29.0	16	36.4	2	6.5	3	6.8
30%	29	37	7	24.1	13	35.1	1	3.4	3	8.1
50%	26	31	5	19.2	9	29.0	1	3.8	2	6.5
KwaZulu-Natal										
No water fluoridation	114	142	33	28.9	49	34.5	7	6.1	10	7.0
10%	109	133	30	27.5	44	33.1	6	5.5	9	6.8
30%	101	115	24	23.8	34	29.6	5	5.0	7	6.1
50%	93	97	18	19.4	24	24.7	4	4.3	5	5.2
Gauteng										
No water fluoridation	74	102	21	28.4	41	40.2	4	5.4	8	7.8
10%	71	95	19	26.8	37	38.9	4	5.6	7	7.4
30%	66	81	15	22.7	29	35.8	3	4.5	6	7.4
50%	61	68	11	18.0	20	29.4	2	3.3	4	5.9
North West										
No water fluoridation	33	35	8	24.2	12	34.3	2	6.1	2	5.7
10%	32	33	7	21.9	11	33.3	1	3.1	2	6.1
30%	31	29	6	19.4	8	27.6	1	3.2	2	6.9
50%	29	26	4	13.8	6	23.1	1	3.4	1	3.8
Mpumalanga										
No water fluoridation	33	45	10	30.3	24	53.3	2	6.1	5	11.1
10%	32	42	9	28.1	22	52.4	2	6.3	4	9.5
30%	30	36	7	23.3	17	47.2	1	3.3	3	8.3
50%	27	30	5	18.5	12	40.0	1	3.7	2	6.7
Limpopo										
No water fluoridation	60	101	9	15.0	39	38.6	2	3.3	8	7.9
10%	59	95	9	15.3	35	36.8	2	3.4	7	7.4
30%	57	82	7	12.3	27	32.9	1	1.8	5	6.1
50%	55	69	6	10.9	20	29.0	1	1.8	4	5.8

5.5 Discussion

5.5.1 Introduction

An appropriate workforce to address the oral health needs and demands of the South African population has been described in a number of publications, research reports, policy documents and position papers. An overview of major decisions and recommendation in this regard was presented in Chapter 2 (see Section 2.2.4, p 39).

The majority of reports on human resources in South Africa have highlighted the inequitable distribution between urban and rural on the one side and the private and public sectors on the other. Recent reports and publication suggested more appropriately trained human resources, for example the NHRP proposed annual productions for the various members of the oral health team (Department of Health, 2006a). In doing so it recognised that consideration had to be given to mobility of health professionals to and from the private sector, migration overseas and other attrition factors.

Three studies have been conducted in South Africa over the past number of years investigating human resources required for oral health. Booyens (1994) applied the WHO/FDI needs model (World Health Organization/Fédération Dentaire Internationale, 1989) to the 1988/89 NOHS data (Department of Health, 1994). This study concluded that more oral hygienists should be trained to address the need for more primary preventive dental services.

Van Wyk (1996) developed a model to determine the future human resource needs for optimal health care for the total population of South Africa where the actual demand for services was used as a point of departure. This study concluded that the levels of human resources required for 2011 would be difficult to attain and a programme of optimal fluoridation was suggested as an absolute necessity to address oral health to the population of South Africa.

Kissoon-Singh (2001) also used the WHO/FDI needs based model (World Health Organization/Fédération Dentaire Internationale, 1989) and the basic

oral health care package (Department of Health, 2001a) to plan human resources for oral health care for KwaZulu-Natal. This study concluded that there was a gross shortage of oral health personnel to meet the oral health needs of this province.

For this study the WHO/FDI human resources planning model (World Health Organization/Fédération Dentaire Internationale, 1989) and a "Service Targets Method" model were used to calculate the oral health human resources required for the delivery of the minimum package of oral care to 4- to 15-year-old children. In both models total human resources and the number of oral hygienists and dentists/dental therapists were calculated separately. Both approaches assumed that the public oral health services would not be responsible for delivering the minimum package of oral care to children older than fifteen and that the oral hygienist would be responsible for delivering the preventive care (group and individual), topical fluoride application, fissure sealants and periodontal care and the dental therapist/dentist the restorative care and extractions.

To illustrate the possible impact of the implementation of water fluoridation on the number of oral health human resources required, treatment need expressed as a percentage of the population or the mean number of teeth in need of treatment (see Table 31, p 110 and Table 32, p 111) were adjusted accordingly based on assumed caries reductions of 10%, 30% and 50% which were applied to both the water fluoridation model and calculating the cost of delivering the minimum package or oral care as well.

Considering the low caries prevalence observed from the 1999-2002 NCOHS (Department of Health, 2003b), only results for an anticipated 30% caries reduction due to the implementation of water fluoridation compared to no water fluoridation will be discussed.

5.5.2 Oral health human resources required on a national level

In general on both the national and all provincial levels the number of human resources required as calculated with the WHO/FDI model is less than the numbers calculated with the "Service Targets Method" model (see Table 51, p 151). The WHO/FDI model calculates that without the impact of water fluoridation 510 oral health workers would be required to deliver the minimum package of care to 4- to 15-year-olds compared to 679 with the "Service Targets Method" model. Similarly at a 30% anticipated caries reduction the number required would be 453 with the WHO/FDI model and 544 with the "Service Targets Method" model.

A possible explanation for this is that the WHO/FDI model places a big emphasis on prevention and control of disease, maintenance of health and high quality restorative care whereas the "Service Targets Method" model converts treatment need based on demand to FTE with all types of treatment need considered as equal. For both models similar treatment times were used for the calculations. The WHO/FDI model also requires DMFT data, whereas the "Service Targets Method" model requires treatment need. Both these datasets used in this study are from the 1999-2002 NCOHS (Department of Health, 2003b). It can be argued that treatment need in this survey might have been overestimated leading to more oral health workers required as calculated with the "Service Targets Method" model.

It is clear from Table 51 (p 151) and both Figure 11 and Figure 12 (p 154), irrespective of whether the WHO/FDI or the "Service Targets Method" models were used for the calculations, that oral hygienists represent the majority of oral health human resources required to deliver the minimum package of oral care to 4- to 15-year-old children. This is not surprising as the minimum package or oral care adopts a much more preventative approach, yet still takes into consideration that active disease needs to be addressed as well through restorative procedures and extractions.

When the impact of the introduction of water fluoridation is taken into consideration at an anticipated caries reduction of 30%, the impact is much larger on the number of dentists and dental therapists required compared to oral hygienists. With the WHO/FDI model (see Figure 11, p 154), compared to when no water fluoridation has been introduced, the number of dentists decrease from 31 to 22 (29%) and the number of dental therapists from 153 to 111 (27.5%), whereas the number of oral hygienists only decrease from 327 to 320 (2.1%). Similarly, with the "Service Targets Method" (see Figure 12, p 154), the number of dentists decrease from 54 to 38 (29.6%) and the number of dental therapists from 272 to 191 (29.8%), whereas the number of oral hygienists decrease from 352 to 315 (10.5%). This can be explained by water fluoridation impacting on the number of restorations and extractions required, whereas it has little impact on the required number of fissure sealants and topical fluoride applications and no impact on group prevention and prophylaxis. These procedures are all provided by oral hygienists.

When results are studied by the type of oral health worker, due to the emphasis op prevention in both models used in this study, oral hygienists represent more than 50% of oral health human resources required to deliver the minimum package of oral care to 4- to 15-year-old children (see Table 53, p 156). Dental therapists represent approximately 30 to 40% and dentists less than 10% of the total human resources required to deliver the restorative care and extraction components of the minimum package of oral care (see Table 54, p 157).

The decreased need for oral health human resources as a result of the implementation of water fluoridation, based on an anticipated 30% reduction in dental caries, can be expressed as a monetary value by using the remuneration paid to a senior oral hygienist, senior dental therapist and a community service dentist employed in the public service as on 1 July 2006 (Department of Public Service and Administration, 2006). The average annual basic salary for both a senior oral hygienist and senior dental therapist appointed on Level 7 in the public service is R106,700. If 30% is added to the basic salary for benefits such as pension, medical insurance and bonuses,

this amounts to R138,700 per annum. The average salary for a community service dentist, including scarce skills allowance, overtime payment, pension, medical insurance and bonuses is R259,000 per annum.

If the mean value of the reduction in the required human resources between those calculated with the WHO/FDI and "Service Targets Method" models is used, 12.5 less dentists (9 with the WHO/FDI and 16 with the "Service Targets Method" model), 61.5 less dental therapists (42 with the WHO/FDI and 81 with the "Service Targets Method" model) and 22 less oral hygienists (7 with the WHO/FDI and 37 with the "Service Targets Method" model) would be required to deliver the minimum package of oral care to 4- to 15-year-olds at an anticipated 30% caries reduction due to the implementation of water fluoridation. This converts to an annual saving in salary of R3,237,500 for dentists, R8,530,050 for dental therapists and R3,051,400 for oral hygienists. The total annual saving in salaries alone for all oral health human resources combined would be R14,818,950 per year.

5.5.3 Oral health human resources required on a provincial level

Population size and treatment need are the two determining variables in calculating human resources in both models. The great variation between provinces for the total number of human resources required as well as the different types of oral health workers can therefore be explained based on these. The 2006 South African mid-year population estimates indicate the largest 4- to 15-year-old population to be in KwaZulu-Natal (2.7 million), followed by the Eastern Cape (2 million), Gauteng (1.8 million) and Limpopo (1.7 million) (Statistics South Africa, 2006). Reports on the 1999-2002 NCOHS highlight the higher caries prevalence in provinces such as the Western and Northern Cape with North West province recording some of the lowest caries prevalence rates (Department of Health, 2003b; Van Wyk et al., 2004). This is reflected in higher treatment needs for the Western and Northern Cape as well.

According to both the WHO/FDI and "Service Targets Method" models, without the impact of water fluoridation, KwaZulu-Natal would require the highest number of human resources (114 and 142 respectively), followed by the Eastern Cape (91 and 84) and Gauteng (74 and 102) (see Table 52, p 153). The lowest number of human resources to implement the minimum package of oral care without the impact of water fluoridation are the Northern Cape (10 and 22), North West (33 and 35), Mpumalanga (33 and 45) and the Free State (33 and 47). Similar results are found for the number of oral hygienists required (see Table 54, p 157).

For dentists and dental therapists combined the largest number are required for KwaZulu-Natal (40 and 59), Eastern Cape (37 and 45), Western Cape (33 and 45) and Gauteng (25 and 49). The lowest number of dentists and dental therapist are needed in the Northern Cape (4 and 17), North West (9 and 14), Limpopo (11 and 47) and Free State (12 and 22) (see Table 51, p 151). This can be explained mainly by the difference in caries prevalence for these provinces.

5.6 Summary

This chapter presented the WHO/FDI and "Service Targets Method" models, results and discussion to calculate the oral health human resources required for the implementation of the minimum package of oral care to 4- to 15-year-old children, taking into account different scenarios for caries reduction achieved through water fluoridation.

In general on both the national and all provincial levels the number of human resources required as calculated with the WHO/FDI model is less than calculated with the "Service Targets Method" model.

For both models oral hygienists represent more than 50% of the total oral health human resources required to deliver the minimum package of oral care to 4- to 15-year-old children.

Dental therapists represent approximately 30 to 40% and dentists less than 10% of the total human resources required to deliver the restorative care and extraction components of the minimum package of oral care.

The conclusions and recommendations from this study linked to water fluoridation and delivering the basic package of oral care as well as the impact on the required number of oral health human resources will be discussed in Chapter 6.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Cost evaluation of the implementation of water fluoridation in South Africa

Decision makers in dental public health should continuously decide on which community-based preventive procedures utilise limited resources optimally. Due to its ease of implementation and equity associated with the artificial fluoridation of public water supplies, it remains the first choice to expose the public to the protective effect of fluoride.

Worldwide declines in dental caries and low caries prevalence in both developed and developing countries, including South Africa, has led to the cost-effectiveness of water fluoridation being questioned, especially in smaller communities and towns.

White et al. (1989) identified ten variables related to the cost of water fluoridation. These include political costs (referenda and campaigning), number of employees (labour cost), choice of chemicals (chemical cost), cost of equipment and instrumentation, annual operational cost (electricity, rent, insurance, shared space), maintenance (annual cost of testing equipment, length of usefulness and replacement cost), natural fluoride content of drinking water, the optimal level of fluoride in drinking water suggested for a country, number of injection sites and cost of installation and consulting engineers' fees.

A model to determine the per capita cost, cost-effectiveness and cost-benefit of the implementation of water fluoridation for seventeen major metropolitan cities, towns and water boards from all nine South African provinces was presented in Chapter 3. This model addressed eight of the ten variables suggested by White et al. (1989). Regulations for the implementation of water

fluoridation for South Africa make provision for consultation with and informing the public (Republic of South Africa, 2000). It is therefore fair to assume that political costs for South Africa will be limited to public communication without referenda. A National Fluoridation Survey conducted in 1998 indicated that the majority of respondents (61.9%) agreed that fluoride should be added to water, 9% disagreed with the remaining 29.1% unsure. (Chikte and Brand, 1999; Chikte and Brand, 2000; Chikte et al., 2000).

Operational costs such as electricity, rent, insurance and shared space was not included in the model, but it can be assumed that this would have represented only a small portion of the total operational cost.

When this model was applied to seventeen major metropolitan cities, towns and water boards from all nine South African provinces, results clearly show that despite a low prevalence of dental caries in South African children, artificial fluoridation of drinking water remains the community-based preventive measure of choice for South Africa. The average per capita cost for all municipalities and water providers is R2.08 per annum, which is extremely low compared to the cost other fluoride vehicles. Other additional benefits of artificially fluoridated water include that it is equitable and passive without direct interaction with a dental provider required.

Results of this study also clearly show that cost-effectiveness and cost-benefit at an anticipated 30% reduction in caries levels as a result of the introduction of water fluoridation is highly favourable. Even at an anticipated 10% caries reduction level, cost-benefit only approached or slightly exceeded a ratio of 0.8 for three municipalities.

Two previous South African studies described the economics of water fluoridation for Gauteng. Smalberger (1998) calculated the per capita cost for Gauteng (based on information supplied by Rand Water in 1995) as R0.11 for poor households and R2.40 for affluent households. At an estimated caries reduction of 25%, saving per person per year varied from R11.70 to R26.60. Based on information supplied between 1998 and 2000, Van Wyk et

al. (2001) calculated the per capita cost for Gauteng as R0.73 and cost-effectiveness and cost-benefit at an anticipated caries reduction of 30% as R6.58 and 0.07 respectively, compared to this study where the per capita cost for Gauteng (Rand Water) was calculated as R2.06 and cost-effectiveness and cost-benefit at an anticipated caries reduction of 30% as R34.18 and 0.2 respectively. Reasons for the difference between the Van Wyk et al. (2001) and this study is a decline in caries prevalence (DMFT for 15-year-olds of 3.3 used by Van Wyk et al. (2001) compared to 1.81 for the current study) and the impact of inflation.

The model presented in this study does not take into account the impact of water fluoridation on physical, social and emotional well-being or changes in quality of life as a result of its introduction. An increase in the number of caries free teeth and declines in caries incidence will without doubt have a positive outcome on these indicators. These include cosmetic advantages of caries free unrestored teeth, reduced discomfort associated with dental treatment, reduction in the number of dental visits and the associated loss of employment time and absenteeism from school or work to have the treatment performed.

The WHO in collaboration with the FDI and the IADR hosted a global consultation on “Oral Health through Fluoride” from 17-19 November 2006. A declaration from this consultation reaffirmed the efficiency, cost-effectiveness and safety of the daily use of optimal fluoride and that access to fluoride for dental health formed part of the basic human right to health (Fédération Dentaire Internationale, 2006).

6.1.2 Cost evaluation of delivering the minimum package of oral care to South African children

Adoption of the PHC approach and reducing the incidence of common oral diseases through a minimum package of care, water fluoridation, and reduction of the consumption of refined sugar were identified as the main principles to address oral health (Republic of South Africa, 1997b). The South

African National Oral Health Strategy (Department of Health, 2005) listed the provision of appropriate disease prevention and health promotion measures based on the minimum package of care on a district level.

According to the 1999-2002 NCOHS (Department of Health, 2003b; Van Wyk et al., 2004) dental caries is more severe in the primary dentition compared to the permanent dentition. Although caries levels for 12-year-olds range between very low and low according to the WHO classification (Barmes, 1977), high levels of untreated caries in all provinces is of major concern. The population under fifteen years of age in South Africa is around 14.3 million which is approximately 32% of the total population (Statistics South Africa, 2003).

The introduction of water fluoridation to major metropolitan areas and larger towns will impact on the number of caries lesions. Restorative dentistry should be simpler as lesions will develop slower and be smaller. In the majority of cases these will be limited to occlusal surfaces as regular exposure to fluoride protects mainly the smooth surfaces of the tooth. This will impact on the human resources required to address especially dental caries.

A model to express the delivery of the minimum package of oral health care as a per capita cost was presented in Chapter 4. This model was applied to 4- to 5-, 6-, 12- and 15-year-olds based on treatment need data from the 1999-2002 NCOHS (Department of Health, 2003b; Van Wyk et al., 2004) which was converted to a cost by applying the 2006 NRPL (Council for Medical Schemes, 2006) and UPFS (Gauteng Provincial Government, 2005) treatment fees on a national level as well as for all nine South African provinces.

To illustrate the possible impact of the implementation of water fluoridation on the cost of delivering the minimum package or oral care, treatment need was adjusted accordingly based on assumed caries reductions of 10%, 30% and 50% as a result of the introduction of water fluoridation.

At an anticipated caries reduction of 30% where the cost of an oral examination and bitewing radiographs were excluded, per capita cost for delivering the minimum package of oral care ranges from R133.45 for 4- to 5-year-olds to R227.10 for 6-year-olds with the cost of restorations and extractions as the major contributor.

Results varied greatly between provinces with those provinces where the highest treatment need exists (Western and Northern Cape) presenting with the highest per capita cost of delivering the minimum package of care. At an anticipated 30% caries reduction due to water fluoridation these were calculated as R215.56 for the Northern Cape and R285.28 for the Western Cape.

6.1.3 Oral health human resources needs for South African children

The four approaches to human resources planning are the human resources to population ratio, health needs, health demands approach and the service targets approach (Hall, 1978). The WHO/FDI model translates need into FTE of oral health personnel required to provide a calculated level of care based on time estimates for each treatment type (World Health Organization/Fédération Dentaire Internationale, 1989). This model makes provision for modifying factors such as demand.

Human resources planning for oral health in South Africa has received a lot of attention. This was reviewed in Chapter 2 (see Section 2.2.4, p 39). Despite several committees and commissions reporting on oral health, very few have been taken seriously and only a limited number of recommendations have been implemented.

Since 1994 three postgraduate studies and reports into human resources for the new South Africa have been published. Booyens (1994) reported on human resources needed to deliver primary preventive services. A modified version of the WHO/FDI human resources model was used in this study. Van Wyk (1996) reported on human resources needed based on the principles of

supply and demand taking into consideration modifying factors, treatment needs and trends. Kissoon-Singh (2001) reported on a human resources plan for oral health care for the province of KwaZulu-Natal. The WHO/FDI human resources model was used for the calculations.

A new debate on human resources planning for oral health was triggered with the publication of the NHRP for South Africa (Department of Health, 2006a) building on recommendations from the Pick report (Pick et al., 2001).

The Pick report used computer simulation models developed by the WHO and historical information from registers of the statutory councils to project supply of a number of health workers, including oral health, over a thirty year period to 2029 using different demographic assumptions (Pick et al., 2001). The report suggested the creation of a single dental auxiliary to replace the oral hygienist and dental therapist, a downward revision of the annual intake of dental students, dental assistants in underserved areas should receive a one year training by dentists to perform simple procedures such as the ART and the scope of the dental therapist should be expanded to include placement and removal of sutures and removable orthodontic appliances and care of wounds and finally a projected requirement for 2029 of 6,413 dentists and 435 oral hygienists.

The NHRP for Health for South Africa provided a framework to guide all stakeholders to ensure an adequate workforce in partnership with government (Department of Health, 2006a). The NHRP proposed an annual production of 120 dental practitioners by 2008, 600 dental therapists by 2009, maintaining current levels of dental technicians, 150 oral hygienists by 2009 and 300 dental assistants by 2008. In a response to the NHRP the editor of the SADJ on behalf of the SADA (Campbell, 2006) criticised the recommendation made for dentists, but welcomed the suggested increase in the production of oral hygienists. It furthermore expressed concern on the suggested number of dental therapists to be trained, especially since current facilities are only equipped to train 300 dentists/dental therapists per year.

In this study the WHO/FDI human resources planning model (World Health Organization/Fédération Dentaire Internationale, 1989) and a "Service Targets Method" model were used to calculate oral health human resources required for the delivery of the minimum package of oral care to 4- to 15-year-old. In both models total human resources and the number of oral hygienists and dentists/dental therapists were calculated separately. Both approaches assumed that the public oral health services would not be responsible for delivering the minimum package of oral care to children older than fifteen and that the oral hygienist would be responsible for delivering the preventive (group and individual), topical fluoride application, fissure sealants and periodontal care and the dental therapist/dentist the restorative care and extractions.

Without the impact of water fluoridation taken into consideration, the number of human resources required to deliver the minimum package of oral care was calculated as 510 with the WHO/FDI model (327 oral hygienists, 31 dentists and 153 dental therapists) and 679 with the "Service Targets Method" (352 oral hygienists, 54 dentists and 272 dental therapists).

When an anticipated caries reduction of 30% is taken into consideration with the introduction of water fluoridation, the impact is much larger on the number of dentists and dental therapists required compared to oral hygienists. With the WHO/FDI model, compared to when no water fluoridation has been introduced, the number of dentists decrease from 31 to 22 (29%) and the number of dental therapists from 153 to 111 (27.5%), whereas the number of oral hygienists decrease from 327 to 320 (2.1%). Similarly, with the "Service Targets Method", the number of dentists decrease from 54 to 38 (29.6%) and the number of dental therapists from 272 to 191 (29.8%), whereas the number of oral hygienists decrease from 352 to 315 (10.5%). This can be explained by water fluoridation impacting on the number of restorations and extractions required, whereas it has little impact on the required number of fissure sealants and topical fluoride applications and no impact on group prevention and prophylaxis. These procedures are all provided by oral hygienists.

When this decreased need for oral health human resources is expressed as a monetary value by using the remuneration paid to a senior oral hygienist, senior dental therapist and a community service dentist employed in the public service as on 1 July 2006 (Department of Public Service and Administration, 2006), it converts to an annual saving of R3,237,500 for dentists, R8,530,050 for dental therapists and R3,051,400 for oral hygienists. The total annual saving in salaries alone for all oral health human resources to deliver the minimum package of oral care to 4- to 15-year-olds at an anticipated 30% caries reduction due to the implementation of water fluoridation would be R14,818,950.

Although this study was limited to calculating the number of human resources required to deliver the minimum package of oral care to 4- to 15-year-olds only, the results would support an increase in the training of oral hygienists to be employed in mainly the public sector. The majority of restorative procedures and extractions required as part of the minimum package of oral care can be provided by a dental therapist.

As of 30 March 2007, 961 oral hygienists, 456 dental therapists and 4,792 dentists were registered with the HPCSA (Health Professions Council of South Africa, 2007). It would require 35% or oral hygienists and between 34% and 60% of dental therapists currently registered with the HPCSA to deliver the minimum package of oral care to 4- to 15-year-old children.

In terms of the Medical, Dental and Supplementary Health Service Professions Amendment Act, 1997 (Act 89 of 1997) (Republic of South Africa, 1997a), one year of CCS in the public sector was introduced for dentists in July 2000. These numbers should be sufficient to address that component of the minimum package of oral care where a dentist is required.

6.2 Recommendations

Despite declines in caries incidence worldwide, artificial fluoridation of drinking water is still regarded as a viable public health measure. Public health professionals at a national, provincial and local level need to enhance their promotion of fluoride and commit the necessary resources for equipment, personnel and training.

Currently no artificially fluoridated water scheme exists in South Africa, despite a Commission of Inquiry into water fluoridation recommending the fluoridation of public water supplies to the optimal fluoride concentration (Republic of South Africa, 1966) and regulations for the introduction of water fluoridation in South Africa which were promulgated on 8 September 2000 (Republic of South Africa, 2000) which compel water providers to fluoridate public water supplies. These regulations were repealed with the repealing of the Health Act of 1977 and have been amended and will follow the normal legal process for approval (Smit, 2007).

This study confirms that in view of a low per capita cost, favourable cost-effectiveness and cost-benefit ratios, which will result in huge savings in the cost of treatment, artificial fluoridation of drinking water remains a feasible community-based preventive option for South Africa, even if only a 10% caries reduction as a result of its introduction is achieved. Evidence exists that fluoridation has the effect of reducing the dental caries disparities between different socio-economic status groups (Burt, 2002), which on its own is a major reason, especially for South Africa, to seriously consider its introduction.

It is strongly recommended that the NFC should use this model and the results from this investigation to convince water providers and local authorities about the benefits of this measure, provided that the national and provincial Departments of Health, who will be the main beneficiaries of improved oral health, make available resources to municipalities and water providers to subsidise its introduction. The national Department of Health should also

launch an information campaign to inform the public of all aspects of the artificial fluoridation of drinking water.

Water fluoridation does not only lead to improved oral health, but will also result in a change in need and demand for oral health services which will translate to a decrease in human resource requirements.

Although the introduction of water fluoridation will impact on caries incidence, caries will still develop. It is strongly recommended that all provinces should actively pursue the introduction of the suggested minimum package of oral care to all children aged younger than fifteen to address especially the large untreated caries component. Appropriate modes of delivery, such as mobile oral health units and equipment, must be investigated to deliver the service to as wide a community as possible in the most cost-effective way. Per capita cost of delivering the minimum package of care will be reduced as a result of the impact of water fluoridation.

To deliver the minimum package of oral care according to the White Paper for the Transformation of Health Services in South Africa (Republic of South Africa, 1997b), will require the creation of a number of posts as well as incentives to attract especially oral hygienists to the public service. The recommendations from the NHRP to increase the number of oral hygienists (Department of Health, 2006a) is supported by this study. This study does not recommend an increase in the training of the number of dental therapists, or the suggested creation of a single dental auxiliary to replace the oral hygienist and dental therapist. The minimum package of oral care places great emphasis on preventive services for which an oral health worker dedicated to prevention, such as an oral hygienist, already exists.

A change in regulations in 1993 to allow dental therapists to enter the private sector and open their own practices, combined with poor salaries and limited career opportunities were listed as the main reasons for dental therapists resigning in large numbers from the public service (Prinsloo, 1994). This

decision and its impact remains controversial and especially the SADA has made its view on this clear on a number of occasions.

A position paper on dental therapists (South African Dental Association, 2000) recommended an immediate moratorium on the training of dental therapist until all key stakeholders have debated this issue. It also urged the HPCSA to rescind the decision to allow dental therapists to practice independently as this was seen as not to be in the best interest of the public sector, especially since the intention was that dental therapists be employed in this sector. In response to the NHRP, the SADA once again called for meaningful negotiations with all stakeholders to address the future of the dental therapy profession (Campbell, 2006).

Results from this study clearly illustrate an urgent need for dental therapists in the public service. Until adequate numbers of oral hygienists have been trained and the future of dental therapists investigated, it is recommended that CCS be expanded to include both oral hygienists and dental therapists with the primary objective of focusing on the delivery of the minimum package of care to children younger than fifteen. When training institutions, in collaboration with the Department of Health and professional bodies, decide on the appropriate numbers to be trained, the envisaged introduction of water fluoridation and its subsequent impact on caries levels should always be taken into account.

A summary of the recommendations from this study are presented in Table 55.

Table 55: Summary of recommendations from this study

Cost evaluation of the implementation of water fluoridation in South Africa: • In view of a low per capita cost, favourable cost-effectiveness and cost-benefit ratios as well as the effect of reducing the dental caries disparities between different socio-economic status groups, water fluoridation remains a viable option for South Africa, even if only a 10% caries reduction as a result of its introduction is achieved; • The NFC should use this model and the results from this investigation to convince water providers and local authorities about the benefits of this measure; • The national and provincial Departments of Health, who will be the main beneficiaries of improved oral health, should make available resources to municipalities and water providers to subsidise its introduction; and • The national Department of Health should launch an information campaign to inform the public of all aspects of the artificial fluoridation of drinking water.
Cost evaluation of delivering the minimum package of oral care to South African children: • All provinces should actively pursue the introduction of the minimum package of oral care to all children aged younger than fifteen to address especially the large untreated caries component; and • Appropriate modes of delivery such as mobile oral health units and equipment must be investigated to deliver the service to as wide a community as possible in the most cost-effective way.
Oral health human resources needs for South African children: • The creation of a number of posts as well as incentives to attract especially oral hygienists to the public service will be required to deliver the minimum package of oral care; • An increase in the number of oral hygienists trained; • To ensure a focus on preventive services the creation of a single dental auxiliary to replace the oral hygienist and dental therapist is not supported; • Meaningful negotiations with all stakeholders to address the future of the dental therapy profession and attracting this profession back to the public sector is urgently required; • CCS be expanded to include both oral hygienists and dental therapists with the primary objective of focusing on the delivery of the minimum package of care to children younger than fifteen; and • The possible impact of the introduction of water fluoridation on human resources should always be considered in planning the number of oral health professionals to be trained.