Periodontal Conditions in Switzerland at the End of the 20th Century

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Aim: To epidemiologically assess the periodontal conditions of the adult population in Switzerland.

Material and Methods: During a ten-year period, a total of 1318 subjects were randomly selected on the basis of a process involving the community rosters in seven regions (Cantons) of Switzerland: (Canton of Berne; Canton of Zurich; Western cantons (GE,VD,NE); Eastern cantons (SG,AI,AR,TG,SH); Southern cantons (VS,GR,TI); Central cantons (LU,GL,ZG,UR,SZ,OW,NW) and Northern cantons (JU,FR,SO, AG,BL)) and encompassing all adult age groups (20–89 years). The subjects were examined in dental offices randomly distributed throughout the country. The number of teeth present, the mean Plaque and Gingival as well as Retention Indices were assessed. Furthermore, pocket probing depths and loss of periodontal attachment were determined on all teeth.

Results: Ninety-four (7.1%) of the subjects were completely edentulous leaving 1224 dentate individuals with an average of 21.65 teeth for analysis. In the youngest cohort (20–29 years) 27.03 teeth were present. During the fourth to the seventh decade of life, tooth loss appeared to follow a linear pattern leaving 17.63 teeth in the age group of 60–69 years. The oldest age group of the 80–89 years old yielded 11.08 teeth. The mean scores of all clinical parameters increased significantly with increasing age. Mean PII in the youngest age group was PII: 0.72 (SD: 0.38) and reached PII: 1.55 (SD: 0.68) in the oldest. The corresponding mean GI were 1.17 (SD: 0.31) and GI: 1.64 (SD: 0.50), respectively. The mean RI increased from 0.24 (SD: 0.29) to RI: 1.34 (SD: 0.70) in the oldest. Mean probing depth increased slightly from 20 to approximately 49 years. Thereafter, mean PPD remained around 3.0 mm. The loss of periodontal attachment increased dramatically after the age of 50.

Conclusions: Periodontitis manifests itself after the age of 50. The pronounced progressive attachment loss in the age cohorts over fifty years explained the marked loss of teeth in some individuals. From a public health point of view, it is indicated to make a major effort for periodontal prevention in the population approaching the second third of life.

Key words: epidemiology, periodontology, prevalence, severity, Switzerland, periodontitis, gingival index, attachment loss

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In an attempt to standardize the examination methodology, the World Health Organization (WHO) developed a periodontal index system which was published under the abbreviation of CPITN (Community Periodontal Index for Treatment Needs) (Ainamo et al, 1982).

This screening index system was subsequently used not only to assess the treatment needs in various populations, but also as an epidemiological tool to determine prevalence, severity and extent of periodontal conditions (For review see Pilot and Miyazaki 1994). However, it has also been realized that the CPITN incorporated into the Oral Global Data Bank of the WHO to provide a possibility for

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comparison of treatment needs in different countries (Pilot and Barmes, 1987; Pilot and Miyazaki, 1994) may be of questionable value for the assessment of the true prevalence and/or severity of periodontal disease (Schürch et al, 1990). In a comparative study transferring data gathered by means of the Gingival Index system (Löe and Silness, 1963), the Retention Index system (Löe, 1967) and Pocket Probing Depths (Glavind and Löe, 1967) transferred into CPITN scores, this screening tool was found to overestimate the prevalence and severity in the majority of the subjects examined, while advanced periodontal destruction was underestimated in other subjects (Schürch et al, 1990). The shortcomings inherent to the CPITN evaluation suggested the use of full mouth examinations with conventional clinical parameters (Lang, 1998) if the prevalence, severity and extent of periodontal diseases were to be evaluated.

Based on three cross-sectional studies and applying clinical parameters, the periodontal status of an adult Swedish population in which 600 individuals were randomly selected at the age of 20, 30, 40, 50, 60 and 70 years in 1973, and 10 and 20 years later (Hugoson et al, 1998), the notion that only a minority of the population developed severe periodontal disease (Burt, 1993) was confirmed. Such results of different epidemiological studies have been reported from various populations around the world (Cushing and Sheiham, 1985; Ismail et al, 1990; Miller et al, 1987; Papapanou et al, 1988; Schürch et al, 1988; Yoneyama, 1988; Baehni and Bourgeois, 1998). In the Swedish population of Jönköpping County, severe periodontal disease was affecting similar proportions of individuals in both studies of 1983 and 1993. Although not encompassing more than 1/6 of the population, it was concluded that the proportion of individuals affected remained rather stable within the last two decades (Hugoson et al, 1998).

However, it has to be noted that the number of teeth per dentate subject increased significantly for each age group except for the 20-year old cohort between 1973 and 1993. The largest difference of higher numbers of teeth between the two examination times was found among the 70-year-old cohort. In 1993, an average of at least five teeth more per subject was present when compared with 1973. Also, edentulism decreased from 37% to 23% in this age group within the two decades. This lead to the assumption that a higher proportion of the elderly population in the 21st century will live with a functional dentition of at least 20 teeth. This, in turn, means that prevalence, severity and extent of periodontal disease in a population may be calculated in advance based on randomized population samples.

In 1985, the periodontal survey in Switzerland was started in the Canton of Berne (Schürch et al, 1988). In order to assess the periodontal conditions of the entire country, all the other 25 Cantons or Half-cantons were evaluated by seven teams of examiners in the following 10 years (Schürch et al, 1991). The specific aim of the present Swiss national survey was to study the periodontal conditions in Switzerland at the end of the 20th century.

MATERIAL AND METHODS

In order to assure a representative distribution of the subjects examined in this survey the test communities were selected on the basis of their geographical location and population distribution (Fig 1).

All subjects were selected at random relying on the central registry of each legislative community. Using randomizing tables addresses of prospective subjects to be examined were selected from the taxation roster and subsequently, the selected subjects were contacted. There were equal numbers of women and men divided into the following age cohorts: 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80–89 years of age.

The selected subjects received a written invitation to participate in the study. They were informed about the purpose, goals, benefits and risks associated with the survey. Several days later, they were contacted by telephone, and, in case of interest, individual appointments for the examination in a dental office of the region were made. In several cantons, second attempts to gather more persons had to be performed. These attempts were initiated by a letter followed by a second telephone call.

Clinical Examinations

The following clinical parameters were scored by six examiners calibrated to the examiner of the original epidemiological survey of the Canton of Berne (Schürch et al, 1988). The calibration procedures were done prior to the examinations in each region. Only when the reproducibility of the clinical param-

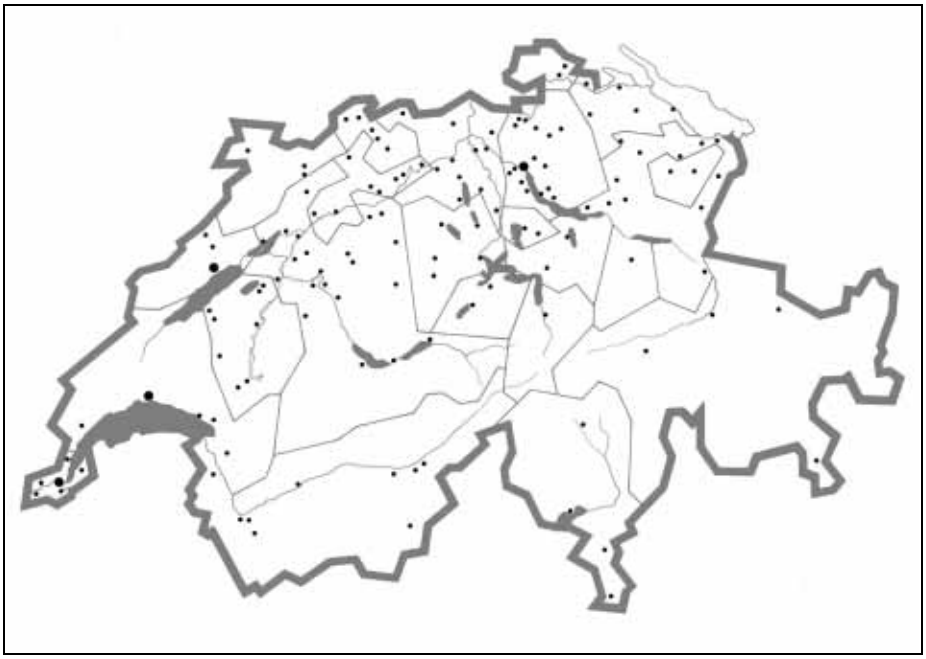

Fig 1 Geographical location of the private practice set-ups used to examine the subjects under optimal clinical conditions. Small dots: Locations with a subject cohort of 14 (7 females and 7 males), randomly selected from the community roster (Population density > 100000). Large dots: Locations with a subject cohort of 28 (14 females and 14 males), randomly selected from the community roster (Population density < 100000).

eters reached 85%, the assessments were initiated in the various regions.

The oral hygiene status was recorded using the Plaque Index (PII) System (Silness and Löe, 1964).

Gingival health or inflammation was assessed by the criteria of the Gingival Index (GI) System (Löe and Silness, 1963). Supra- and subgingival calculus, ill-fitting margins of dental restorations and open cavities were recorded for all the teeth according to the criteria of the Retention Index (RI) System (Löe 1967).

The scores of these three parameters were assessed on three buccal (mesial, mid- buccal, distal) and one lingual surface of each tooth.

Pocket Probing Depths (PPD) and Loss of probing Attachment (LA) were measured to the nearest millimetre on the same four aspects of each tooth as for PII, GI and RI using a M1 periodontal probe with a point diameter of 0,45 mm (Glavind and Löe 1967). Third molars were not included in the study.

Statistical Analyses

The statistical calculations were performed using the Statistical Analysis System (SAS) (SAS, Institute 1985). Mean indices per individual, per age and cohort gender and per urban and rural population were computed. Number of missing teeth, as well as means and frequencies of the various indices were obtained.

Significance tests between group means for indices were calculated using general linear models with linear age effects, person effects random within gender and the various regions examined with multivariate comparisons (SAS-procedure GLM). This type of analysis is powerful and statistically valid due to the allowance for inter-mouth variations, and reliable as it assesses several effects (e.g. personal, gender and various regions) simultaneously, while still allowing for unequal numbers of measurements per subject (lost teeth). Basic variables were tooth-averages of the Plaque, Gingival and Retention Indices. With regard to the analysis or percentage of teeth present, the primary response variable used was mouth percentage of teeth present. This avoids, similar to the GLM-analysis of Gingival, Plaque, and Retention indices, the problem of dependent observations (SAS Institute, 1985).

RESULTS

A total of 1318 subjects accepted the invitation to be examined: 657 women (49.8%) and 661 men (50.2%) attended the examinations (Table 1). This corresponded to an average response rate of the randomly selected subjects of 51% ranging from

Table 1 Clinical parameters for women and men. Mean values and SD of teeth populations

Sex	No. of patients	mean PII	(SD)	mean GI	(SD)	mean RI	(SD)	mean PPD	(SD)	mean PAL	(SD)	mean no. of teeth present	(SD)	mean % of teeth lost
men	616	1.06	(0.57)	1.37	(0.38)	0.71	(0.58)	2.89	(0.85)	3.32	(1.78)	20.00	– 9.2	28.70
women	608	0.94	(0.57)	1.28	(0.40)	0.65	(0.58)	2.79	(0.84)	3.13	(1.47)	20.30	– 9.2	27.60
p-value		< 0.00011		< 0.00011		> 0.1(NS)1		< 0.051		< 0.051		> 0.1	(NS)2	

1 Test based on random person effects model
2 Test based on mouth overages

42% to 59% in the different geographical regions. The age distribution of the subjects examined is reflected in Table 2. The 1318 subjects presented with a total of 26519 teeth indicating that 28.14% (10385) of 36904 teeth had been lost on an average. This resulted in a mean dentition of 20.12 teeth (Table 1). Ninety-four (7.1%) of these subjects were completely edentulous and hence, were excluded from further analysis. This left 1224 dentate individuals with an average of 21.65 teeth.

The study thus represents approximately one individual per four thousand adult Swiss citizens (≥ 20 years). Table 2 indicates the dental status with the number of teeth present in the different age cohorts. In the youngest cohort (20–29 years) 27.03 teeth were present. During the fourth to the seventh decade of life, tooth loss appeared to follow a linear pattern leaving 26.03 teeth in the age group of 30–39 years; 23.51 teeth in the age group of 40–45 years; 20.60 teeth in the age group of 50–59 years; and 17.63 teeth in the age group of 60–69 years. The seventy to seventy-nine years old had 13.29 teeth, and the oldest age group of the 80–89 years old yielded 11.08 teeth.

A dentition of 20 teeth was present in 67.3% of the total population; 22% of the subjects showed an anterior dentition of twelve teeth or less. In relation to the age cohorts it is evident that the dentition with at least 20 teeth (at least premolar occlusion) is generally observed until the age of 59 years. After the age of 60, the mean number of teeth present dropped below 17 (Fig 2cb).

The mean Plaque Index of the entire population was PII: 1.00 (SD: 0.57); the mean Gingival Index, GI: 1.32 (SD: 0.40); and the mean Retention Index, RI: 0.68 (SD: 0.58). Since the presentation of an average of clinical parameters for a population with various age groups is not appropriate, Fig 2ca shows the mean scores and standard deviations (SD) of the different clinical parameters in the different age cohorts. The mean scores of all clinical parameters increased significantly with increasing age (Fig 2ca). The mean PII in the youngest age group was PII: 0.72 (SD: 0.38) and reached in value of PII: 1.55 (SD: 0.68) in the oldest age group. The corresponding values for the mean GI were GI: 1.17 (SD: 0.31) and GI: 1.64 (SD: 0.50), respectively. Also, the mean RI increased from R: 0.24 (SD: 0.29) in the youngest age group to RI: 1.34 (SD: 0.70) in the oldest age group.

Mean PPD values increased steadily from 2.40 mm in the youngest cohort to 3.00 mm in the age

Table 2 Clinical parameters of the different age Groups, mean values and SD of teeth populations

Age group (Yr)	No. of patients	mean PII1	(SD)2	mean GI1	(SD2)	mean RI1	(SD)2	mean no. of teeth present[1]	(SD)2	mean % of teeth lost
1 (20–29)	192	0.72	(0.38)	1.17	(0.34)	0.24	(0.29)	27.00	(1.88)	3.50
2 (30–39)	241	0.74	(0.45)	1.17	(0.39)	0.45	(0.44)	26.00	(2.77)	7.00
3 (40–49)	231	0.91	(0.53)	1.29	(0.33)	0.64	(0.49)	23.20	(6.10)	17.10
4 (50–59)	195	1.09	(0.51)	1.37	(0.37)	0.83	(0.57)	19.50	(8.40)	30.40
5 (60–69)	195	1.26	(0.59)	1.48	(0.37)	0.99	(0.60)	15.50	(11.20)	44.60
6 (70–79)	122	1.34	(0.58)	1.50	(0.38)	0.91	(0.59)	10.40	(8.82)	62.90
7 (80–89)	48	1.55	(0.68)	1.64	(0.50)	1.34	(0.70)	8.10	(8.57)	71.20
p-value3		< 0.0001		< 0.0001		< 0.0001		< 0.0001		

[1] Average over all teeth present
[2] Standard deviation from all teeth present
[3] Test based on mouth averages

cohort of 50–59. Thereafter, PPD did not seem to increase in the three oldest cohorts (Fig 2cc). The mean LA increased almost linearly from 1.97 mm at age 20–29 to 4.66 mm at age 80–89 (Fig 2cc).

Analyzing the mean values of the clinical parameters separately for women and men showed significantly higher mean scores for the men than for the women for both PII and GI (Table 1). Mean PPD and mean LA as well were also significantly ($p < 0.05$) higher for men than for women.

However, no significant differences between the mean scores for men and for women were found for the mean RI and the mean number of teeth present.

Table 3 demonstrates the mean clinical index values for the different regions in Switzerland assessed by different examiners. Again, the differences between the various geographic regions reached statistical significance for all parameters evaluated. The highest mean PII was found in the Canton of Berne, which was the first region to be examined in 1985. The variation between mean GI in the different regions of Switzerland was small with the highest values being reported in the Cantons of Berne and Eastern Switzerland and the lowest in the French speaking Cantons. This latter region also showed by far the lowest Retention Index. The Cantons of Berne and the Eastern Swiss Cantons showed the highest mean PPD and the Cantons of Zurich, Aargau and Basel the lowest mean PPD. With regards to the attachment level, similar observations were made with the Eastern Swiss Cantons yielding the greatest loss of attachment and the Canton of Zurich the least.

Analyzing urban and semi-urban settlements with a dentist against rural settlements without a dentist and comparing the results to those of the reference Canton of Berne, significant differences were found for all clinical parameters except for the mean GI.

The frequencies of individuals yielding various percentages of bleeding on probing (GI > 1) are depicted in Fig 3. Only every twelfth (8.16%) individual belonged to a group with up to 10% of the sites bleeding on probing. Every fifth individual (21.8%) belonged to a group showing bleeding on probing at between 11% and 25% of the sites. This demonstrates that approximately 30% of the population had a mean BOP of less than 25%. A similar frequency analysis for the attachment level showed that massive loss of attachment defined as 6 mm or greater, either alone or in combination with PPD ≥ 3 mm, is not a frequent observation within the population; 81.7% have up to 10% of the sites with AL ≥ 6 mm and 85.5% if the criterion of PPD ≥ 3 is added.

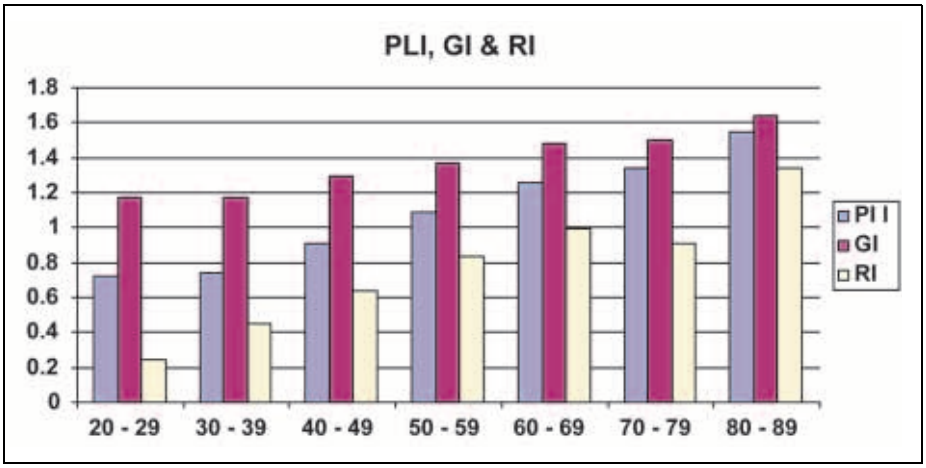

Fig 2a

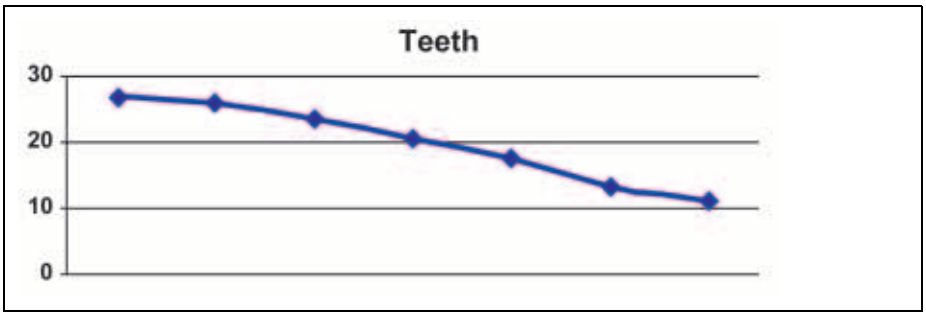

Fig 2b

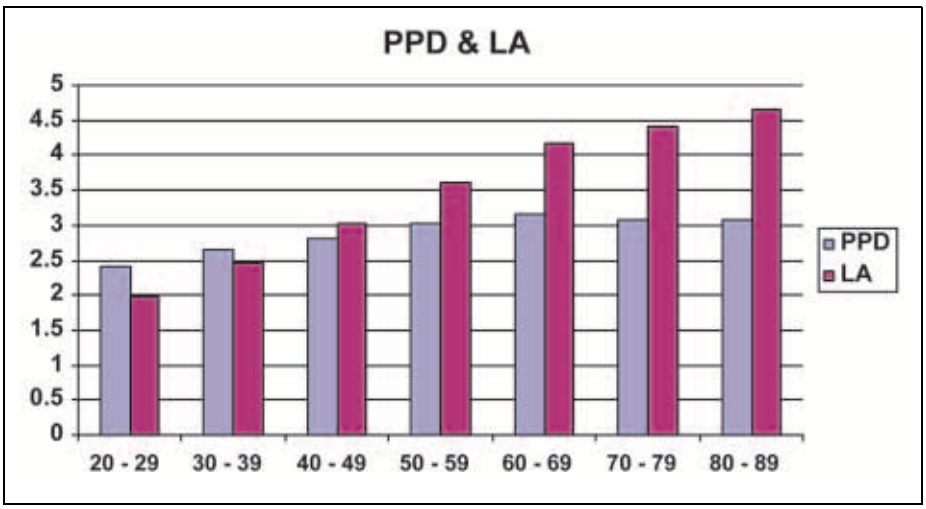

Fig 2c

Fig 2a to 2c Clinical parameters of the different age cohorts: a) Mean individual Plaque Index (PII), Gingival Index (GI) and Retention Index (RI). b) Mean individual number of teeth present. c) Mean individual Pocket Probing Depth (PPD) and Loss of periodontal Attachment (LA) in millimetres. Analysis based on 1224 dentate subjects for periodontal parameters and on all 1318 subjects for the mean individual tooth loss.

DISCUSSION

The population sample of the present survey was randomly selected from the local legislative register of each settlement selected. The survey was performed in a staggered approach, where one region of Switzerland was examined after the other. The first region examined was the Canton of Berne, in which 23 communities evenly distributed throughout the Canton were selected (Schürch et al,

1988). Of those, 59% agreed to participate for the examination at the first challenge. In the two other subsequently examined geographical regions the agreement to participate at the first challenge averaged 51%, thus representing approximately one randomly selected subject per 4000 adult Swiss citizens. It has to be realized, however, that approximately 20% of the foreign workforce in Switzerland are not represented in this population sample. The fact that the data were collected within a time period of ten years may lead to regional differences in the clinical results obtained in more recent years, which actually represents an improvement in the conditions due to prophylactic activities. In that respect, the Canton of Zurich with the lowest mean PPD and LA, and the French speaking part of Switzerland (Karsegard et al, 2001) with the lowest mean PII, GI and RI were the last regions examined.

Since every region was examined by a separate examiner calibrated to the examiner of the first region (Canton of Berne) each region may be analyzed separately. However, despite the statistically significant differences in the clinical parameters of the various geographical regions, the total population examined in this study represents still a randomly distributed population of a western industrialized country at the end of the 20th century.

Only 7% of the population examined were completely edentulous. These subjects were predominately found in the two oldest age cohorts. This is substantially less than what had been reported for an elderly population in Switzerland aged 60–95 years and referred to a geriatric ward. In this population, almost 60% of the patients where edentulous (Stuck et al, 1989). This would indicate that total edentulism is no longer a major public health issue for the whole population, but still a health problem of the elderly and frail.

In the partially edentulous remaining 93% of the population, the number of teeth present decreased from age 30–89 years from approximately 27 to 11 teeth. During the first two cohort decades, one tooth was generally lost per 10 years. After age 40, however, three to six teeth were lost per 10 years. The reason for this tooth loss, i.e. whether or not it may be attributed to the sequellae of dental caries, periodontal diseases or trauma, remains speculative.

The fact that an average of 8 teeth was lost between age 40 and age 70, however, may indicate that a significant number of teeth were lost as a result of chronic periodontitis (Papapanou 1996).

Table 3 Clinical parameters for women and men, mean values and SD of teeth populations

Region	No. of patients	mean PII1	(SD)2	mean GI1	(SD2)	mean RI1	(SD)2	mean PPD1	(SD)2	mean PAL1	(SD)2	mean no. of teeth present1	(SD)2	mean % ofteeth lost
1 Berne	191	1.27	(0.62)	1.39	(0.44)	0.93	(0.62)	3.17	(0.80)	3.20	(1.21)	20.60	(8.8)	26.30
2 South Eastern CH	145	1.17	(0.74)	1.31	(0.57)	0.89	(0.77)	2.20	(0.80)	3.02	(2.18)	19.20	(9.4)	31.60
3 Central and Southern CH	160	0.86	(0.54)	1.29	(0.23)	0.73	(0.54)	2.66	(0.68)	2.86	(1.64)	18.10	(10.1)	35.40
4 Eastern CH	175	1.09	(0.52)	1.38	(0.31)	0.43	(0.48)	3.72	(0.78)	4.32	(1.92)	18.60	(10.3)	33.60
6 Zurich	136	0.92	(0.59)	1.37	(0.33)	0.60	(0.50)	2.36	(0.55)	2.15	(0.80)	19.90	(8.9)	28.90
6 Western CH	256	0.85	(0.43)	1.23	(0.44)	0.34	(0.29)	2.93	0.72)	3.60	(1.32)	22.20	(7.9)	20.80
7 Northern CH	161	0.87	(0.44)	1.35	(0.29)	1.02	(0.47)	2.50	(0.49)	2.89	(1.25)	21.20	(8.5)	24.20
p-value3		< 0.0001		< 0.0001		< 0.0001		< 0.0001		< 0.0001		< 0.0001		

[1] Average over all teeth present
[2] Standard deviation from all teeth present
[3] Test based on mouth averages

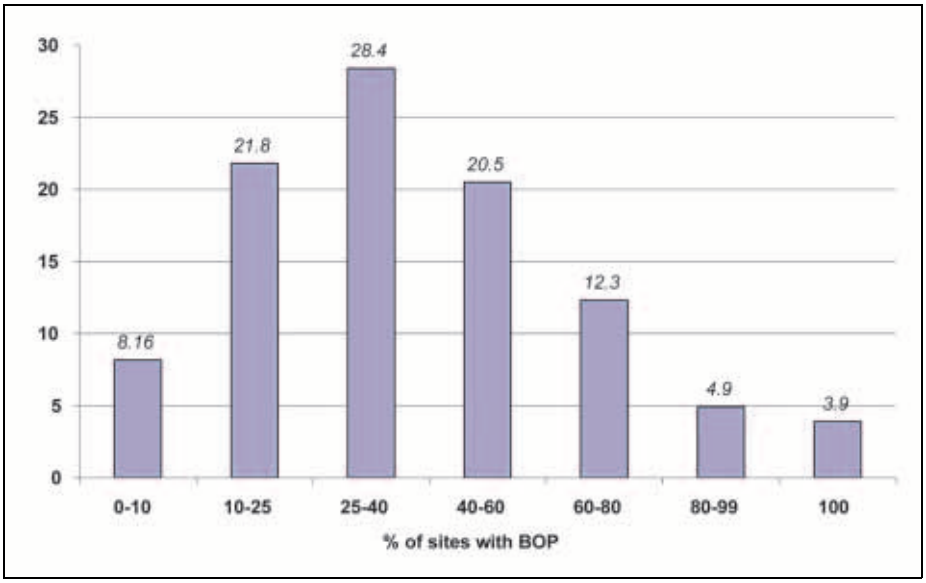

Fig 3 Distribution of the population according into various categories of mean Bleeding on Probing (BOP) percentages.

Several cross-sectional and longitudinal studies (Ankes et al, 1988; Käyser, 1981, 1989, 1994; Witter et al, 1988, 1990, 1994 a,b) have indicated that individually optimal chewing function may be guaranteed even for shortened dental arches yielding a premolar to premolar or first molar to first molar occlusion. If the concept of the shortened dental arch is considered as a limited treatment goal for subjective optimal chewing function, it may be stated that two-thirds of the partially edentulous subjects in the present study still fulfilled the premolar to premolar occlusion requirement. The reduction of posterior support below the number of 20 teeth generally occurred after the age of 60, again indicating that unsatisfactory subjective chewing comfort may be a problem of the elderly. Owing to the ongoing prophylactic efforts of the dental profession, it may be anticipated that shorted dental arches to the premolar to premolar occlusion may be found in even higher age cohorts in the future.

The mean PII and GI in the present survey was 1.0 and 1.32, respectively. Such mean values appear rather high when compared with other surveys of similar nature (Hugoson et al, 1998). During the course of two decades, a positive impact of dental health had been demonstrated owing to the preventive measures instituted in the 1970's. However, the frequencies of plaque and gingivitis in percent did not further improve in the later decade, which corresponds to the examination period of the present study.

In the study of an adult Swedish population (Hugoson et al, 1998), approximately 30% to 40% of the tooth surfaces were covered by plaque in all age groups resulting in the presence of approximately 25% to 30% of the gingival units being inflamed. Converting the mean PII and mean GI of the present study to plaque and gingivitis percentages would certainly result in higher proportions for those two parameters indicating that oral hygiene conditions in Switzerland clearly lag behind the Swedish results. It is understood, however, that mean scores of a population only allow general speculations about the clinical significance of higher plaque and gingivitis scores. More details may be obtained from the analysis of different age cohorts. In that respect it may be stated that up to the age of approximately 49 years, gingivitis scores correspond more closely to the experience of the Swedish adult population, while the elder age cohorts exceed the standards from Sweden. Again, this indicates the necessity to increase the prophylactic efforts especially for the patients in the last third of their life. It is interesting to note that the loss of teeth in the adult Swedish population (Norderyd and Hugoson, 1998) was substantially lower in all age cohorts after age 30 than observed in the present Swiss survey. Since tooth loss represents the ultimate outcome variable to evaluate effective preventive systems, it has to be admitted that the Swedish adult population of the County of Jönköpping maintained more teeth after the age of 30, most likely owing to higher standards of oral hygiene.

In the present survey it was evident that probing depth increased slightly from 20 to approximately 49 years. Thereafter, mean PPD remained approximately around 3 mm. Nevertheless, the loss of periodontal attachment increased dramatically after the age of 50. This indicates that periodontitis most likely manifests itself after the age of 50; while it has been demonstrated that attachment loss occurs already in the younger age cohorts (Heitz-Mayfield et al, 2003; Schätzle et al, 2003). The pronounced progressive attachment loss in the age cohorts over fifty years of the present study also explains the marked loss of teeth in the some population groups. From a public health point of view it is, therefore, indicated to make a major effort for periodontal prevention in the population approaching the second third of life in Switzerland.

Since the present study represents a cross-sectional survey, it has to be realized that the conclusions drawn apply to the demographic distribution of the population at the end of the 20th century in Switzerland. They cannot, however, be extrapolated to future population samples. Owing to the combined efforts for periodontal prevention and care, it is to be expected that, in one to two decades, the periodontal conditions of Switzerland will more closely resemble those encountered in Scandinavia of today.

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