

From the DEPARTMENT OF DENTAL MEDICINE

Karolinska Institutet, Stockholm, Sweden

# MEDICAL SCREENING IN DENTAL SETTINGS

Göran Friman



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# Medical screening in dental settings

## THESIS FOR DOCTORAL DEGREE (Ph.D.)

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# To Maria



*Amore, Heidi Fosli 2015*

## **Front cover**

The internationally renowned, award-winning Norwegian artist and my dear friend Heidi Fosli, acclaimed for her revolution of impressionism, read my articles. With its content and our friendship as inspiration, I asked Heidi to create a work of art for me.

This piece of art, like all her work, was painted intuitively out of her sentiments, which she described in words as: life, death, disease, research results, prevention, future window, light and discovery.

Heidi named it *Discovery*, 2016 and it is shown here on the thesis front cover. Thank you, Heidi!

# ABSTRACT

## Background

Findings have shown medical screening in dental settings to be cost-effective by achieving both financial savings and health benefits. The general purpose of this thesis was to study the possibility of early identification of individuals with undiagnosed diseases in a cooperative effort between dentistry and healthcare.

The aims were to identify patients in a dental setting at risk of having or developing high blood pressure or high plasma glucose, and to investigate possible associations between these conditions and periodontal status, followed by a seven-year term study of the correlation between initial screening results and the progression of health. Further on, the patients' experiences as well as the attitudes of some relevant authorities and organizations were explored.

## Methods

A total of 170 dental patients were consecutively included at their regular annual check-up. Data on age, weight, height, amount and use of tobacco and pharmacological treatments for cardiovascular disease and diabetes were collected through self-reported information in a written health declaration, along with data on systolic and diastolic blood pressure, and plasma glucose. Clinical and radiographic examinations revealed data about periodontal status by probing periodontal pockets and measuring marginal alveolar bone loss by means of x-rays. Patients who exceeded normal diastolic blood pressure and plasma glucose values were referred to healthcare for diagnosis and care.

With a strategic sampling of patients, authorities and organizations, 17 patients and 13 representatives for authorities and organizations were interviewed. The interviews were recorded and transcribed. The transcriptions were coded and categorized in a manifest analysis, followed by a latent, interpretive analysis.

The initial screening's 170 participants were then asked to take part in a seven-year follow-up study. Data were collected through a repeated written health declaration.

## Results

Thirty-nine patients exhibiting risk values were provided referrals and 24 (14.1%) of the 170 participants required additional care. The correlation between dentistry and health care concerning blood pressure was 64.5% ( $p < 0.001$ ), while the correlation was 40.0% ( $p < 0.001$ ) concerning plasma glucose. Among middle-aged men and elderly subjects, the data showed a significant correlation between marginal alveolar bone loss and high systolic blood pressure ( $p < 0.001$ ).

The manifest analysis of the patients' experience resulted in three categories: Positive attitude to screening but dental professionals need to have specific knowledge of medical screening; Dental care provides continuity but is not a neutral environment; and Feedback on the medical screening results and desired cooperation between dental and healthcare services. The manifest analysis of the approached authorities and organizations resulted in four categories: Medical screening ought to be established in the society; Dentistry must have relevant competence to perform medical screening; Dentistry is not the only context where medical screening could be performed; and Medical screening requires cooperation between dentistry and healthcare.

The latent analysis of the patients' experiences pointed out the importance of the patient feeling that the procedure is carried out properly and safely, and identified requests for clear feedback concerning the results of the screening. The representatives for the authorities and organizations were positive to, but uncertain about, the concept of medical screening in dental settings. They requested further scientific knowledge and guidelines as well as long-term follow-up of medical screening.

The follow-up study consisted of 151 participants. The risk for pharmacological treatments for hypertension after seven years for those not receiving pharmacological treatment at the initial screening was 54.2 times greater ( $p < 0.0001$  CI 9.8-300.3) for those with a systolic blood pressure  $>160$  mm Hg than for those with a systolic blood pressure  $<140$  mm Hg. Regarding diabetes, it was not possible to do risk calculations due to the limited group sizes. The changes in treatment were not significant.

## **Conclusions**

An opportunistic medical screening seems to identify at least one in ten patients with undiagnosed hypertension or incorrect pharmacological treatment, and risk patients referred by dentistry who are not considered to require further healthcare interventions may benefit from an annual screening. The results also emphasize the need for increased cooperation between dentistry and healthcare.

## LIST OF SCIENTIFIC PAPERS

- I. Friman G, Wårdh I, Nilsson G and Hultin M. Identifying patients in dental settings at risk of cardiovascular disease and diabetes.  
*Cardiovascular System*. 2013; 1:5: 9.
- II. Friman G, Golestani G, Kalkali A, Wårdh I, Hultin M. Patient Experiences of Medical Screening Performed by the Dental Services: A Qualitative Study.  
*Open Journal of Stomatology*. 2013; 3: 497-503.
- III. Friman G, Hultin M, Nilsson GH, Wårdh I. Medical screening in dental settings: a qualitative study of the views of authorities and organizations.  
*BMC Res Notes*. 2015; 8: 580.
- IV. Friman G, Hultin M, Nilsson GH, Wårdh I. Long-term follow-up of opportunistic medical screening for hypertension and diabetes within dentistry – a descriptive study.  
*In manuscript*



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## LIST OF ABBREVIATIONS

A2MG	Alpha 2-macroglobulin, pro-inflammatory biomarker
BP	Blood pressure
CI	Confidence Intervals
CVD	Cardiovascular disease
DM	Diabetes mellitus
HbA1c	Glycated haemoglobin, average level of plasma glucose
IGT	Impaired glucose tolerance
OR	Odds Ratios
PD	Periodontal disease
PG	Plasma glucose
SBU	Swedish Agency for Health Technology Assessment and Assessment of Social Services ( <i>Statens beredning för medicinsk utvärdering</i> )
SD	Standard deviation
US	United States
WHO	World Health Organization

# 1 PROLOGUE

Once upon a time Maria, my wife, best friend and colleague, said to me:

- We have been worked in our own clinic in Filipstad, a small town in mid-Sweden, for nearly 20 years now. We see our patients once a year and we can follow how their oral health develops, generally for the better, but also their general health. When a patient tells me about, or I see signs of, deteriorating general health, I ask, ‘Have you seen a healthcare provider?’ Often, they answer ‘No!’

“Why can’t we check their blood pressure (BP) and plasma glucose (PG) for example, when we do our annual check-up?



**Figure 1.**

That was how it all started (Figure 1)!

At all of our patient appointments, we try to see the whole person, not just a mouth with a row of teeth – few or many. We ask them how they are doing. Usually they answer with something like “All right”, “I’m still standing” or “Could be worse”. When we then ask, “How are you for real?” we hear how things are for real.

We, the dental nurses and two dentists working at our clinic, all share a view advanced by some ancient Greeks and shown by today’s research: there is a connection between oral health and general health. With that philosophy and knowledge, we started early with the routine of sending referrals to healthcare services when we had good reason to suspect local or general lesion outside our competence. Our patients preferred that we sent a referral instead of seeking care themselves.

We decided to start a project, “Medical screening in dental settings”, and conduct opportunistic medical screening by registering BP and PG in combination with the usual dental, periodontal, mucosal data and general anamnesis at the annual check-up. But first we had to study the existing current scientific literature.

We contacted Gunilla Nordenram, now associate professor emerita at the Department of Dental Medicine at Karolinska Institute, with whom we already collaborated in the area of gerodontology development. She agreed to supervise us in the early phases and then Inger Wårdh “inherited” us, as she was successor associate professor and accepted the main supervisor assignment. They were both enthusiastic but also cautioned us that the journey would be long and time-consuming. To support us, Margareta Hultin, specialist in periodontics, and Gunnar Nilsson, professor of family medicine, agreed to come in as co-supervisors.

Concurrently with the literature studies, we hired medical staff who taught all of us at the clinic the practice and the theory behind screening and obtained necessary medical equipment. We wanted to have the right tools and the skills to be able to answer the patient's questions. Furthermore, we informed the primary healthcare centres and the private doctor in the town and established cooperation with Dr. Nils Regnström, who took the primary responsibility for the follow-up of our general medical test results that indicated disease risk. Sadly, Nils Regnström passed away before he could review the analysed data. We thank him for the indispensable and insightful contributions he provided while he was with us.

With the tireless and never-ending support of Maria and our three daughters, Sandra, Petra and Mikaela, I began my doctoral thesis journey.

## 2 THESIS SUMMARY

Obesity is a growing health condition with following disorders and sequelae like diabetes and hypertension with their disease complications, which occur if not treated early in the disease progression.

Opportunistic medical screening could be a possible approach for the early identification of individuals at risk. As individuals generally visit dental care more often than medical care, medical screening in dental settings could be a model for improving public health and reducing individual suffering and costs to society. Dental care as a context may be particularly suited, as current research shows associations between oral and general diseases.

By performing a screening and documenting the findings, the effects of such activity could be determined. How patients experience such a new feature at a regular dental examination could also be valuable to document, as well as the authorities' and organizations' attitudes to such activities. Further on, conducting a follow-up after some years to provide guidance about the possible long-term effect of opportunistic medical screening in dental settings would also be interesting.

With these skills, an implementation could more easily be achieved. This is what this thesis is about.

### **3 INTRODUCTION**

#### **Setting and epidemiology**

For this thesis, data was collected from a population in a small industrial community in a sparsely populated area in mid-Sweden with about 10,600 residents (1). Data concerning medication for high BP and diabetes mellitus (DM) and frequency of visits to dental care was taken from a 2012 study conducted by Värmland County through questionnaires with self-reported information. The results from the municipality concerned for the age group 60-70 years showed that 29.4% medicated for high BP and 17.1 % for DM, as compared with 29.2% medicating for high BP and 12.5% for DM in the whole county (2).

These figures can be compared with Swedish national data collected in 2012 for the 45-64 age group: 22% (CI 20.8-23.7) medicated for high BP and 6% (CI 5.1-6.7) for DM, and for the 65-84 age group: 55% (CI 53.6-57.3) medicated for high BP and 14% (CI 12.3-15.0) for DM (3).

These data indicate that the population in the municipality concerned had more identified and medicating diabetics and less identified and medicating individuals with high BP than elsewhere in Sweden.

## 4 BACKGROUND

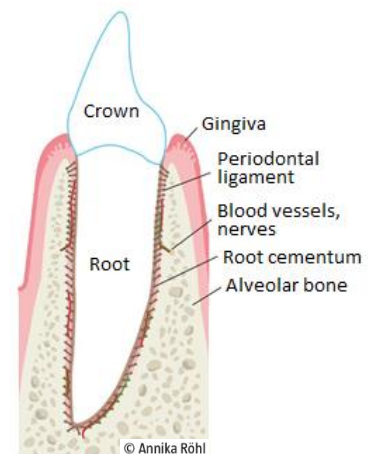
The objective of this thesis was to identify patients in an ordinary real-world dental setting at risk of already having or developing high BP or high PG, investigate possible associations between these conditions and periodontal status and explore the correlation between the results registered by medical screening in dental settings and follow-up assessments concerning the need for medical treatment and/or lifestyle changes performed by medical staff.

Another objective was to form a basis for routines before the implementation of opportunistic medical screening activity in dental settings. This aim was meant to be achieved by literature studies, clinical testing and my own research on the concept.

### 4.1 PERIODONTITIS

#### General features and condition

In the oral cavity, teeth are attached by the periodontium to the bone tissue of the jaws. The periodontium comprises gingiva, periodontal ligament, root cementum and alveolar bone (Figure 2). The functions of the periodontium are also to maintain the integrity of the mucosal barrier and to protect the underlying tissues, blood vessels and circulatory system (4). The tooth perforates the mucosal barrier, and when the free gingiva that surrounds the tooth is healthy it closes tightly around the tooth to seals and protects against intrusion.

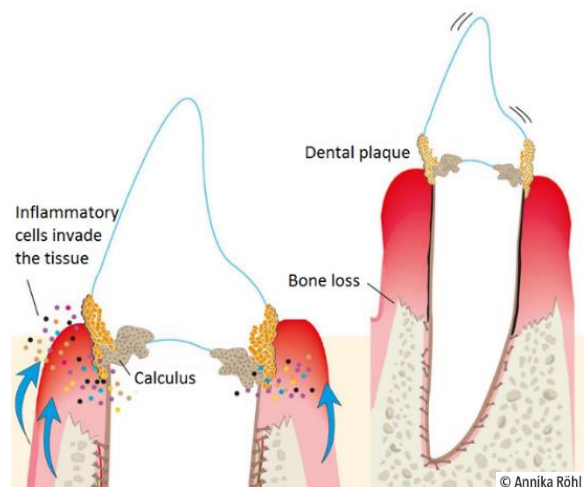


**Figure 2.**

#### Pathogenesis

Bacteria in dental plaque is an important driving factor in the inflammatory response of the periodontal tissues. This host-mediated immunological defence can lead to epithelium ulceration and disruption, and ultimately an irreversible destruction of the periodontium (Figure 3).

The diagnosis of current or historical periodontal disease (PD) is made by clinical examination, and determined by bleeding on probing of the gingival and periodontal pocket, using a probe equipped with a



**Figure 3.**

0.5-mm ball tip. This leads to clinical assessment of inflammation in the tissue, registering of probing depth and clinical attachment loss. Periodontal status can also be historically assessed by a radiographic examination measuring the marginal alveolar bone loss on bitewing radiographs (4).

## Epidemiology

Several index systems for the evaluation of these parameters have been developed, which makes it difficult to compare the prevalence of periodontitis among the different studies. In Sweden, though, epidemiological data from 1973 to 2003 showed an unchanged 6-8% prevalence of advanced periodontitis and an increase of periodontal healthy individuals from 8 to 44%. As explanation for the improved periodontal health, the authors refer to better oral hygiene (5).

Chronic periodontitis is the most frequent form of periodontitis. It progresses at a very slow rate and is usually painless until the disease develops into severe periodontitis (4).

Periodontitis is often referred to as a “silent disease”, which means that the patient is more or less unaware of or is neglecting the disease.

## 4.2 PERI-IMPLANTITIS

### General features and condition

Implant installations and jawbone-anchored dental replacements are an increasingly used therapy when masticatory function or aesthetics are adversely affected due to tooth loss.

At approximately six weeks’ post-installation, the surrounding bone of the implant forms a stable hard tissue with close proximity to the implant. This “bone-implant contact” is called osseointegration (Figure 4).

### Pathogenesis

Peri-implant diseases consist of two different states: peri-implant mucositis with bleeding on probing of the mucosa and no bone loss, and peri-implantitis with mucositis and loss of supporting bone (Figure 5). For conditions presenting probing depths of 5 mm or more and suppuration, peri-implantitis can usually be diagnosed (6).

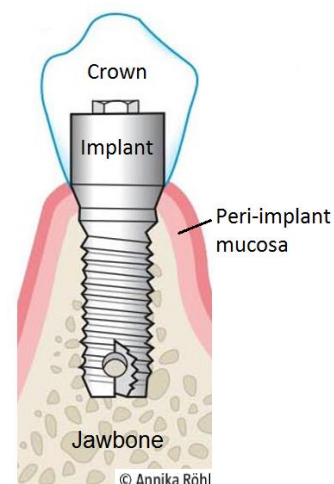
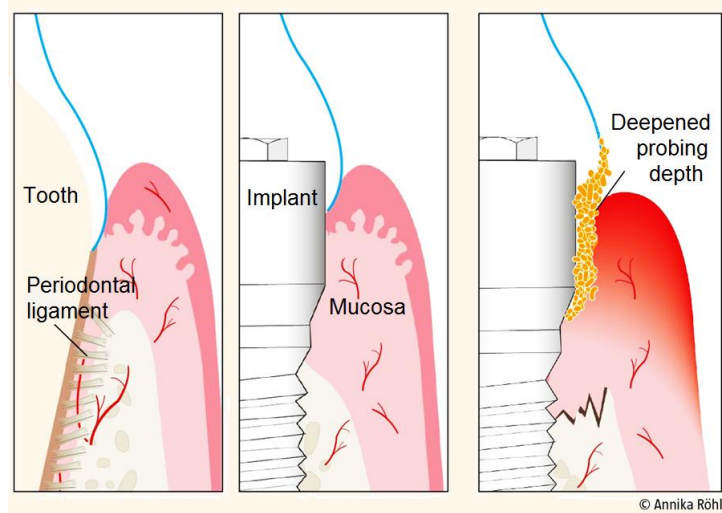


Figure 4.



## Epidemiology

As for periodontics, there are several index systems for evaluating and determining the prevalence of peri-implant mucositis and peri-implantitis. However, it is reasonable to assess that peri-implant mucositis is present in 40-48% of the implant patients and the proportion of patients with peri-implantitis is registered in 30-55% (4).

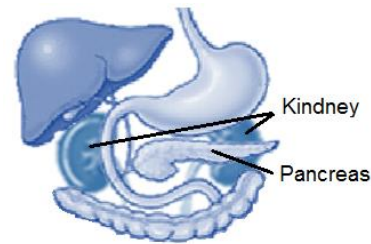


**Figure 5.**

## 4.3 DIABETES

### General features and condition

Diabetes mellitus is a term for a chronic disorder that arises when the pancreas (Figure 6) cannot produce a sufficient amount of insulin or the human cells cannot use insulin. The condition is diagnosed and followed up by registering the instantaneous level of PG or the level of HbA1c, which reflects an average level of PG over the past two to three months. Haemoglobin, Hb, is a blood pigment that carries oxygen and HbA1c is a form of haemoglobin that is bound to glucose. The hormone insulin is required to transport the glucose from the blood stream into human cells, where it is used as energy (7).



**Figure 6.**

There are three main types of diabetes and triggering risk factors (7):

- Type 1 diabetes – genetic and ethnic disposition, infections and other environmental influences
- Type 2 diabetes – genetic and ethnic disposition, obesity, physical inactivity, poor nutrition, past history of gestational diabetes, aging
- Gestational diabetes – appears during pregnancy

## Pathogenesis

### *Type 1 diabetes*

An autoimmune reaction is behind type 1 diabetes. The human immune system attacks the insulin-producing beta cells ( $\beta$ -cells) in the tissue called the islets of Langerhans in the pancreas. The onset often occurs suddenly and in children or young adults. Common symptoms are abnormal thirst, constant hunger and a dry mouth combined with frequent urination and extreme tiredness (7).

### *Type 2 diabetes*

The most common type of DM is type 2 diabetes. The onset is insidious usually in adults, but nowadays increasingly seen in adolescents and children. The beta cells can still produce insulin, but human cells that need glucose become resistant and so the human-produced insulin is insufficient. Common symptoms are about the same as in type 1: abnormal thirst, constant hunger and a dry mouth combined with frequent urination and extreme tiredness.

The insidious development of type 2 starts with conditions named impaired glucose tolerance (IGT) or impaired fasting glucose, which are preliminary stages of diabetes, sometimes called “prediabetes” (7).

In addition to the already mentioned risk factors for type 2 diabetes, recent research suggests that sleep disturbances can be added to the list (8).

### *Gestational diabetes*

Hyperglycaemia, an elevated level of plasma glucose that occurs and is first detected at any time during a pregnancy, is categorized as gestational diabetes mellitus (7).

### *Diabetes complications*

If there is a lack of insulin or a deficiency in cell uptake of PG, glucose remains circulating in the blood stream. High levels of glucose lead to vascular damage in the capillaries and blood vessels, which causes CVD and organ lesions in the kidneys, nerve tissues and eyegrounds, among other health complications. People with uncontrolled diabetes or poor glucose control are also at increased risk of developing infections and have an increased risk of inflammation (7).

The level of PG is so important as one of the main causes of CVD that an oral glucose tolerance test, performed before hospital discharge after acute myocardial infarction, can disclose an unidentified glucose abnormality and thereby the risk for a future major cardiovascular event (9). A hyperglycaemic state also



**Figure 7.**

results in various pro-inflammatory effects (Figure 7) which affects the inflammatory response of the whole body's organs and tissues (10).

## **Epidemiology**

Most diabetics live in low- and middle-income countries. According to a global study 382 million people worldwide were estimated to have diabetes in 2013 and the forecast for 2035 is 592 million in the 20-79 age group. In Sweden, the percentage of diabetics in 2013 was 6.4% and estimated to rise to 6.6% by 2035 (11). The most prevalent form of DM is type 2, and its prevalence continues to increase. Up to 91% of adults with DM in high-income countries have type 2 diabetes (7).

In a 2001-2004 study using data from Stockholm, Sweden, mean age 74.0, the prevalence for diabetes was 9.5% (12). A 2009 study of a population aged 65–74 in northern Sweden showed a prevalence of 12.0% for diabetes (13).

The pharmacological costs for treating solely DM in Sweden account for 4% of the total costs of the disease. The other 96% of costs are attributed to complications and visits to healthcare facilities (14). Globally, 12% of the healthcare expenditure was spent on DM and related complications (7).

## **4.4 HYPERTENSION**

### **General features and conditions**

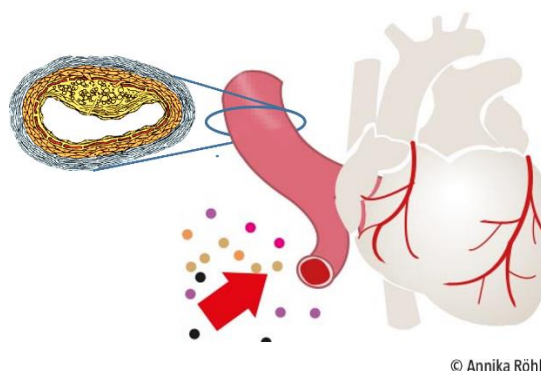
Blood pressure is usually recorded with a BP cuff with a mercury manometer or instrument which records the corresponding value. There are two pressures that are registered, one high and one low. The higher pressure, the systolic BP, is when the heart beats and pumps the blood around. The lower one, the diastolic BP, is when the heart relaxes between beats. When the BP is raised, with systolic BP exceeding 140 or diastolic BP exceeding 90 mm Hg, the condition is termed hypertension (HT) and antihypertensive pharmacological treatment is indicated independent of level of total cardiovascular risk (15).

A raised BP increases the risk of stroke, heart enlargement, incidence of other CVDs and finally death. The risk is based not only on BP, but increases in combination with other factors such as genetic disposition, diabetes, raised blood lipids, obesity, poverty, low educational status, advancing age, male gender and psychological factors and behavioural risk factors as tobacco use, physical inactivity, sleeping disorders, unhealthy diets and harmful use of alcohol. The higher the BP and the more risk factors, the greater the risk (16). In addition to the already mentioned risk factors for hypertension and CVD, recent research suggests that sleep disturbance can be added to the list (8).

## Pathogenesis

HT is an age-related, slow-developing and leading risk factor for premature death. The diastolic and systolic BP have different meanings as risk indicators at different ages. The diastolic BP is the best risk indicator for those under 50 years of age, especially women. Between ages 50-65, the two pressures show equal significance, but over age 65, the systolic BP is the best risk indicator for cardiovascular events. Most modern risk charts are nevertheless based on the systolic pressure, combined with age, smoking, blood lipids and diabetes (16). When HT presents due to peripheral arterial disease, vascular stiffness or ambulatory pulse pressure, which is defined as the difference between systolic and diastolic BP, can predict cardiovascular events (17), especially in patients with type 2 diabetes (18).

HT is one cause of atherosclerosis, which in return affects BP. Atherosclerosis is a complex pathological process, an inflammatory process affecting medium- and large-sized blood vessels, and develops over many years. Fatty material and cholesterol are deposited inside the lumen of arteries lining the endothelium (Figure 8). This occurs when the inner surface of the vessel is exposed to raised levels of low-density lipoprotein cholesterol (LDL cholesterol) or



**Figure 8.**

other substances like circulating inflammatory mediators and free radicals (19). Through this inflammatory initiation and process, an atheromatous plaque is formed (16).

These deposits, plaques, cause the inner surface of the blood vessels to become more narrow and less elastic, making it harder for blood to flow through. Eventually, the plaque can rupture, triggering the formation of a blood clot (16).

## Epidemiology

Hypertension is a major risk factor for public health due to its association with cardiovascular disease (CVD) and kidney events. HT affects more than one-third of adults aged 25 and older worldwide according to the World Health Organization (WHO) and is responsible for 9.4 million of the deaths from CVD each year. It is estimated that there will be 23 million cardiovascular deaths worldwide due to HT by the year 2030 (16).

The Swedish prevalence in the beginning of the early 2000s of HT, mean age 74.0 years, was 74.9%, and 41.6% of the population medicated (12). The 2009 study of a population aged 65–74 in northern Sweden, showed a 71.9% prevalence for HT and 44.9% of the study population used pharmacological treatment with antihypertensive drugs (13).

## 4.5 UNIDENTIFIED DIABETES AND HYPERTENSION

### Diabetes

In 2015, 46.5% of all adult diabetics (20-79 years) worldwide were undiagnosed and unaware of their disease. Yet these figures vary by region, with 39.3% in Europe, 29.9% in North America and the Caribbean and 66.7% in Africa. Most of these cases involved type 2 diabetes and individuals living in low- and middle-income countries (7).

Untreated and unknown IGT involves a high risk of progressing to type 2 diabetes later in life and 6.7% of all adults worldwide are estimated to have IGT. Half of these are under the age of 50 and if the condition progresses to diabetes, the link to the development of CVD is significant (7). In 2015, the International Diabetes Federation estimated that, worldwide, one in eleven adults aged 20-79 has diabetes and one in two adults with diabetes is undiagnosed (7).

A free medical screening for non-hospitalized subjects, provided at the main entrance of a hospital in Israel and supervised by healthcare, revealed that among subjects without known DM, 14.3% were at risk of prediabetes and 1.6% at risk of diabetes (20).

### Hypertension

Undetected and uncontrolled hypertension increases the cardiovascular risk of stroke and additional CVD. The prevalence of HT differs globally depending on the socio-economic conditions. In low-, lower-middle- and upper-middle-income countries, the prevalence among adults is around 40% and in high-income countries around 35% for both genders (21).

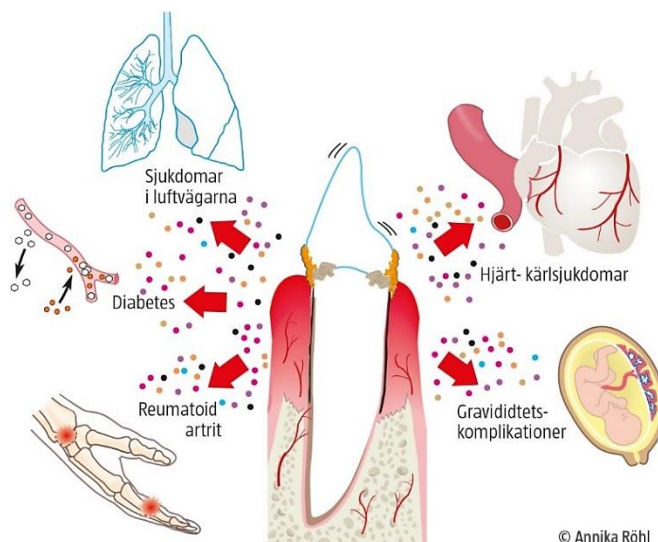
The medical screening of non-hospitalized subjects, mentioned above, revealed that among subjects without known hypertension, 9.6% had blood pressure  $\geq 140/90$  (20). In a 2005 study of urban Chinese adults aged 20-79, 37.3% of the participants with HT were undiagnosed. The article was summarized by the conclusion: “the prevalence of pre- and undiagnosed-hypertension was ~ 50% among urban Chinese adults. Abdominal obesity, low socio-economic status, alcohol drinking, physical inactivity and type 2 DM may be indicators for pre- and undiagnosed-hypertension” (22).



**Figure 9.**

## 4.6 ASSOCIATIONS' BETWEEN ORAL HEALTH AND GENERAL HEALTH

The epidemiological associations of PD and CVD have been recognized for just over three decades now and the association with DM has been acknowledged for over a century (23). In 2012, the scientific consensus was that PD exhibited associations with multiple systemic conditions, but there was a lack of knowledge about their nature and whether there were causal links. Then, current conditions and diseases were (Figure 10): DM, CVD, osteoporosis, preterm low-birthweight babies, respiratory diseases and rheumatoid arthritis (24).



**Figure 10.**

Added to this list are those sequelae which can be indirectly caused by hyperglycaemia and diabetes, for example kidney disease (25). Oral bacteria have also been shown to contribute to the development of the pathology of Alzheimer's disease (26).

Apart from the already mentioned systemic effects of DM, an increased local PG level in the periodontal tissues provides an increased accumulation of end products of glucose metabolism, which leads to increased interaction between leukocytes and endothelial cells and changes in leukocyte functions. The increased levels of pro-inflammatory cytokines in periodontal tissues also stimulate tissue degradation (27).

Epidemiological and biological data indicate that periodontitis, in turn, can affect diabetes through adverse effects of PD on glycaemic control, diabetic complications, and the development of type 2, and possibly gestational diabetes (28). More studies are needed to explain and clarify the two-way relationship between DM and PD.

Possible associations between PD and CVD, such as atherosclerotic lesions, are presented in a current literature review (29). PD increases the risk for CVD by increasing the levels of pro-inflammatory cytokines and adhesion molecules in plasma and thrombotic markers like fibrinogen, which in combination with impaired endothelial function may cause the development of atherosclerotic lesions. The inverse there is that periodontal treatment reduces the risk of CVD by decreasing the plasma levels of inflammatory markers and improves the endothelial function (29).

Metabolic syndrome, as defined by WHO in 1998, is a condition in which a compilation of factors including dysglycaemia, visceral obesity, atherogenic dyslipidaemia (elevated triglycerides and low levels of high-density lipoprotein, HDL) and hypertension leads to an increased risk of developing CVD and DM (30). Increased understanding of the associations with PD could promote inter-professional cooperation and practice (31).

### **Oral microbiome**

All environmentally exposed surfaces of the human body – skin and mucous membranes – have their different resident microbiota. The microbiota is the ecological community of commensal, symbiotic and pathogenic microorganisms inhabiting the human body in health and disease. Humans have a dynamic and intimate relationship with these microorganisms and a majority contribute to the health of the host.

However, “Periodontal disease is a consequence of a breakdown in the normally homeostatic balance between the commensal microbiota and the immune and inflammatory systems of the tissues. In this regard, periodontal infections and the response to them represent an excellent, accessible, and tractable system to understand the underlying principles of a wide range of inflammatory diseases of humans characterized by a dysbiotic commensal microbiome” (4).

This is of major importance to the host-mediated immunological inflammatory response that leads to periodontal epithelium ulceration and disruption, and opens the gates for intrusion and accessibility to the bloodstream (4).

A recent review article (2016) presents growing evidence showing associations between the oral microbiome and oral and non-oral conditions/diseases including, in addition to those already mentioned, oral cancer, gastrointestinal and pancreatic cancer (32).

### **Diet-associations between oral health and general health**

The expression “the way to a man’s heart is through his stomach” nowadays probably can apply to both genders, and diet must pass the mouth first. A current euphemism could then be “the way to human health is through the mouth”.

This statement finds support in the fact that the Mediterranean diet has an immune protective effect against atherosclerosis and other chronic low-grade inflammatory diseases like visceral obesity, the metabolic syndrome and type 2 diabetes, neurodegenerative diseases and cancer, which is considered to be a chronic inflammation (33, 34).

Another sort of association is in the meaning of the oral and general tissue response concerning similar effects of different diets. A diet low in carbohydrates, rich in omega-3 fatty acids, vitamins C and D, antioxidants and fibre, without any changes in oral hygiene, significantly reduces gingival and periodontal inflammation. This conclusion was presented in an admittedly small limited pilot study, published in 2017, but provides incentive for future

studies in the field, given that this diet has a similar effect on other general inflammatory diseases (35).

#

*Common sense has long held that the mouth is part of the body. Science verifies this. The next step is therefore increased interprofessional cooperation between dental care and medical services for improved public health.*

#### **4.7 ATTENDANCE RATE**

A questionnaire study with self-reported information conducted by the county of Värmland in 2012 revealed that the attendance rate of visits to dental care during a period of two years in the county of Värmland was 94.3% for the 60-70 age group and the results from the municipality concerned was 93.2% (2) in comparison with 72.7% of the adult population nationwide in Sweden from the years 2010 to 2011 (36).

These data indicate that the 60-70 age group in the municipality concerned visited dental care more frequently than the adult population in Sweden and that dentistry has a high degree of coverage in the age group.

In the United States (US), 24.1% of adults over the age of 18 did not have contact with a general healthcare provider in 2008, but 23.1% of those did see a dentist during that year (37).

#### **4.8 PATIENT'S AWARENESS OF BLOOD PRESSURE AND PLASMA GLUCOS**

As part of the clinic's internal quality development, a study was conducted in the previously mentioned sparsely populated area in mid-Sweden to examine how well ordinary people knew their vital signs such as BP and PG. At the annual check-up, 257 patients were asked about their awareness of vital signs. Information about their health history was also collected through a self-administered written health declaration.

The mean age was 60.7 years with a range of 21-92 years. The participants were 43.6% men and 56.4% women. The awareness of one's own BP was more common, 54.5%, mean age 64.8, than the awareness of the PG 33.1%, mean age 64.2. For more details, see Tables 1 – 3.



**Table 1.** Patient's awareness of vital signs and health history; total and according to gender

Variables	Total yes		Men yes		Women yes	
	N=257		n=112		n=145	
	n	%	n	%	n	%
Awareness of blood pressure	140	54.5	59	52.7	81	55.9
Having hypertension	88	34.2	33	29.5	55	37.9
Awareness of plasma glucose	85	33.1	38	33.9	47	32.4
Having diabetes mellitus	13	5.1	8	7.1	5	3.4

Opportunistic medical screening is most valuable for those who do not know their vital signs, so a descriptive analysis of unawareness was carried out among those who had not been previously diagnosed.

**Table 2.** Not medicating patient's unawareness of blood pressure; total, according to gender and mean age

Variables	Total			Men			Women		
	N=169			n=79			n=90		
	n	%	age/year	n	%	age/year	n	%	age/year
Unawareness of BP	100	59.2	54.6	45	57.0	53.8	55	61.1	55.2
Standard deviation, SD			15.334			14.094			16.378

**Table 3.** Not medicating patient's unawareness of plasma glucose, total, according to gender and mean age

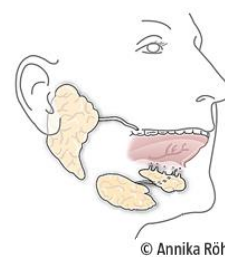
Variables	Total			Men			Women		
	N=244			n=104			n=140		
	n	%	age/year	n	%	age/year	n	%	age/year
Unawareness of PG	169	69.3	58.8	71	68.3	57.0	98	70.0	60.2
Standard deviation, SD			15.639			14.424			16.407

This internal quality study revealed that a little fewer than two-thirds of those without diagnosed hypertension were unaware of their blood pressure and more than two-thirds of those without diagnosed DM were unaware of their PG.

## 4.9 SCREENING OF SALIVARY MARKERS AND FOR OSTEOPOROSIS

In the study, which constituted the basis for this thesis, an invasive method was used to screen for the risk of high PG levels (38). The PG was measured by a capillary blood sample.

Saliva from the salivary glands (Figure 11) is a complex liquid containing an entire library of endogenous substances. Studies have shown that the human salivary proteome contains certain proteins which can be linked to prediabetes and type 2 diabetes. One of these biomarkers is the pro-inflammatory alpha 2-macroglobulin (A2MG) (39).



**Figure 11.**

A non-invasive method for the detection of prediabetes and diabetes can increase the patients' likelihood of complying with and facilitating the sampling. In accordance with the bidirectional causal connection between diabetes and periodontitis (10), and as the salivary A2MG has a significant correlation with HbA1c, fasting glucose and periodontal status, this biomarker can provide an opportunity to use a non-invasive test for diabetes screening and provide a biological indicator for diabetes control from a saliva sample (40).

With an increasing elderly population, the incidence and prevalence of cancers will be expected to increase (41). Salivary biomarkers have proven to be a promising diagnostic and prognostic tool for the detection of several types of cancers such as breast cancer, lung cancer, ovarian cancer, pancreatic cancer and, not least, for oral squamous cell carcinoma, which is the most common oral cancer (42). Since the human papillomavirus (HPV) is behind a large number of oral cancers, screening of salivary biomarkers can be considered for additional groups other than the elderly (43). Further research is still needed regarding salivary biomarkers, but they are likely to play a significant future role in medical screening in dental settings.

Dental professionals can also play a role in screening for osteoporosis, a major public health problem especially in post-menopausal women, by using a basic radiography measurement technique to determine the thickness and morphological changes of mandibular inferior cortical bone (44, 45).

## 4.10 MEDICAL SCREENING IN GENERAL

In a Cochrane review article, general health checks were evaluated and the authors found that such activity did not reduce morbidity or mortality. Nevertheless, they recommended that screening for specifically targeted tests, such as for cardiovascular risk factors, chronic obstructive pulmonary disease, diabetes or kidney disease, should be studied further in the future (46). The Swedish Agency for Health Technology Assessment and Assessment of

Social Services (SBU) has commented on the Cochrane review and studied other literature, which shows a positive effect of screening for specifically targeted disease like CVD (47).

In 2009, an English NHS Health Check programme was introduced in adults aged 40–75 with the objective of early identification by healthcare providers of non-communicable diseases like HT and DM (48). A retrospective evaluation of the programme in a multi-ethnic population was published in 2015. Over a five-year period, 10.8% of the individuals were diagnosed as at high risk of unidentified CVD and 5.7% of the individuals were diagnosed with unidentified type 2 diabetes (49).

### **Ethical considerations**

Ethical problems concerning screening is a controversial issue, not least in genetic carrier screening (50). But the impact of diabetes screening seems not to have a negative influence on patients' perception of health-related quality of life regardless of whether the screening results in a diagnosis or not (51). Under what circumstances should the screening be performed? In 1996, SBU proposed principles for when screening is beneficial (52):

- What impact does the disease have?
- Is the diagnosis method good enough?
- Is there access to effective treatment?
- Are the costs in proportion to the impact?

### **Selection for screening**

If the above principles are met, there may be other guidelines in the selection of risk patients. When selecting individuals for DM screening, the risk factors can be appropriate criteria for selection (7):

- Genetic and ethnic disposition
- Obesity
- Physical inactivity
- Poor nutrition
- Past history of gestational diabetes
- Advancing age

HT is also an age-related disease and the age-related increase in systolic blood pressure is linear between 30-40 years of age and slightly steeper for women than for men (53). An opportunistic medical screening of those who attended a daily outpatient clinic for HT was conducted in India and involved adults aged 30 and above. This study showed that the frequency of undiagnosed HT and prehypertension in an opportunistic screening in rural areas was 17.9% and 37.7%, respectively. Obesity was the most modifiable risk factor. A majority of the undiagnosed HT was detected in the 30-49 age group and in males (54).

The risk factors for HT mentioned in the “Global Atlas on Cardiovascular Disease Prevention and Control” can form criteria to consider in a screening selection for HT (16).

- Genetic disposition
- Obesity
- Diabetes mellitus
- Raised blood lipids
- Poverty
- Low educational status
- Advancing age
- Male gender
- Psychological factors
- Tobacco use
- Physical inactivity
- Sleeping disorders
- Unhealthy diets
- Harmful use of alcohol

In the selection for screening and identifying undiagnosed DM and HT, the sampling becomes quite similar.

#### **4.11 COOPERATION BETWEEN DENTAL AND MEDICAL CARE**

In Swedish county councils and regions, there is generally access to hospital dental care in connection with healthcare. With the objective of specifying the care activities, the field of “orofacial medicine” has developed and comprises the prevention, diagnosis and treatment of complex oral conditions related to systemic diseases and/or disabilities. Where those activities occur, natural collaboration between dental and healthcare exists.

Historically, oral health and general health have been separated in legislation, education and service delivery. However, recent developments and new knowledge are forcing a shift to unite dentistry and medicine or at least increase and manifest an enhanced cooperation between primary care and general dental care (55).

The role of education is important. In the early 2000s, a trend started in the US and dental hygienists, as prevention specialists, took an integral role in healthcare to detect the presence of general diseases, which resulted in educational requirements for medical screening (56).

Healthcare has also reached an increased awareness of the need for education and knowledge in oral and dental core competencies, particularly when frail or chronically ill patients more often seek healthcare than dentistry (55). In Sweden, Uppdrags AB at Karlstad University has taken a nationally unique initiative and offers a course in oral and dental core competencies directed at nurses ([www.kau.se](http://www.kau.se)).

In order to encourage healthcare to increase cooperation, the Swedish National Board of Health and Welfare recommended in 2015 that healthcare providers refer diabetics with an increased risk for impaired oral health to dental care. These National Guidelines for Diabetes Care promote increased cooperation (57).

The Texas Administrative Code, US, RULE §108.8 “Records of the Dentist” stipulates that records must include documentation of “Vital signs, including but not limited to blood pressure and heart rate when applicable in accordance with §108.7 of this title”. Registration of BP is a regular routine when visiting dental settings!

Dr. Lisa Simon, Harvard School of Dental Medicine, Boston US, finishes her article “Overcoming Historical Separation between Oral and General Health Care: Interprofessional Collaboration for Promoting Health Equity” with the Conclusion (55):

“As awareness of inequality in access to oral health and its importance in overall health grows, dentists, physicians, and other health professionals have begun to take up the mantle of oral health integration. Such efforts can take the form of novel insurance structures, practice models, or other innovations. Above all, both dental and medical education will play critical roles in preparing future practitioners for these changes. Working and training together, trainees in medicine and dentistry can unify oral and general health care.”

#

*Medical screening in dental settings can be a start for some and stimulus for others.*

#### **4.12 MEDICAL SCREENING IN DENTAL SETTINGS**

Results from different sorts of medical screening in dental settings have been published since the mid-1990s (58). However, US Professor Michael Glick’s 2002 article “Screening for traditional risk factors for cardiovascular disease. A review for oral health care providers” became somewhat of a starting point for publications of research related to medical screening in dental settings (59). In 2007, Dr. Sevek Engström published one of the first articles in Sweden about medical screening in dental settings (60).

Since then, many articles have been published on this subject and medical screening seems to be supported by patients, dental hygienists, dentists, physicians and authorities and organizations (61, 62). Research which, among other data, is presented in these dissertation articles.

## **Selection for screening**

Should all dental patients be screened or just certain groups? First of all, previously listed general risk factors can form the basis for a selection in addition to oral health registrations and oral infections, specifically PD, active and historical. Historical PD can be seen as marginal alveolar bone loss on bitewing (63). Number of missing teeth can also serve as the basis due to an increased risk for cardiovascular events and all-cause mortality (64).

In the implementation of the intraoral soft tissue screening, which is particularly important due to premalignant and malignant lesions, all oral mucosa is scanned (65). This screening also comprises the underside of the tongue and assesses the extent of sublingual varices, which recently has shown to have an association to HT (66).

## **Levels for risk**

An elevation of systolic BP higher than 180 mm Hg or diastolic BP higher than 110 mm Hg is used by many dental clinicians in the US as a cut-off value for medical consultation and referral (67). But the maximum levels for risk is something determined by the cooperation partner, the healthcare provider, as dental care does not impose a general medical diagnosis. Working closely with healthcare is therefore a prerequisite for medical screening in dental settings.

## **5 AIMS OF THE THESIS**

### **General aims**

The general aim of this thesis was to increase cooperation between dental and medical care for early identification of individuals at risk for public health problems.

### **Identifying patients in dental settings at risk of cardiovascular disease and diabetes (Study I)**

To identify patients in a dental setting at risk of already having or developing high blood pressure or high plasma glucose, investigate possible associations between these conditions and periodontal status, and explore the correlation between screening results and follow-up assessments concerning the need for medical treatment and/or lifestyle changes performed by medical staff.

### **Patient experiences of medical screening performed by the dental services: A qualitative study (Study II)**

To explore how medical screening performed by the dental service was perceived from the patient perspective.

### **Medical screening in dental settings: a qualitative study of the views of authorities and organizations (Study III)**

To describe the view of authorities and organizations in a Swedish context.

### **Long-term follow-up of opportunistic medical screening for hypertension and diabetes within dentistry – a descriptive study (Study IV)**

To describe the distribution of diagnosis, pharmacological treatments and risk for hypertension and diabetes after seven years among patients opportunistically screened in a dental setting, and to analyse possible correlations over time between and among study outcome groups, gender and age.

## 6 MATERIAL AND METHODS

### 6.1 STUDY I

The study was approved by the local Ethical Committee in Uppsala, Sweden (file 2005:358) and was conducted in agreement with the terms of the Helsinki Declaration.

#### Setting

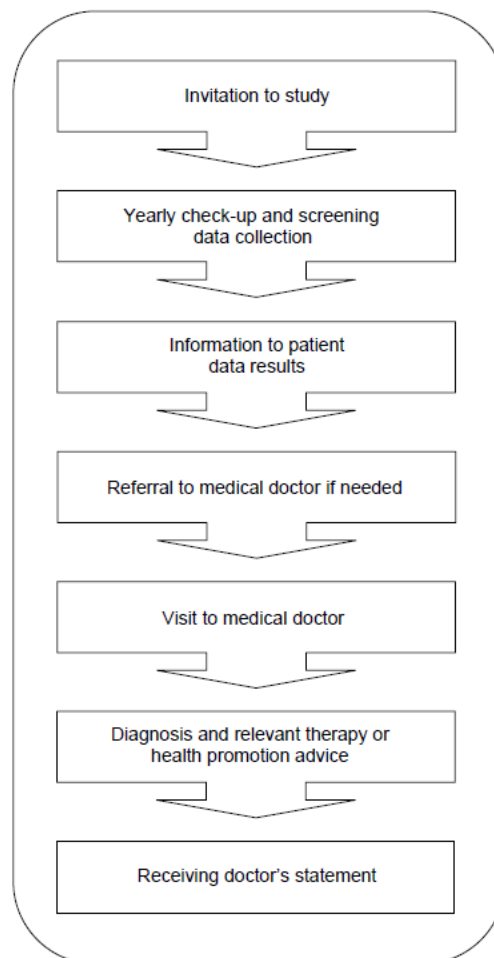
This study was performed in an everyday dental setting in a small town in mid-Sweden. At the time of the study, the clinic was responsible for treating about 1,450 adult patients with a mean age of approximately 57 years ranging from 20 to approximately 100 in age. All patients were enrolled in an individualized prophylactic care program and had appointments with the dental hygienist or prophylactic dental nurse on an individual basis. In addition to the prophylactic program, an annual full-mouth dental examination was generally performed on each patient by a dentist. For a flow chart of the medical screening, see Figure 12.

#### Subject selection

Two hundred seven consecutive regular patients  $\geq 40$  years of age who had been recalled to their regular yearly check-up visits between March and October 2004 were invited to participate in the study. One hundred seventy patients agreed to participate. Upon receiving both verbal and written information about the study, all subjects included gave their informed consent for the study to be conducted.

Study subjects were divided into two groups:

1. Middle-aged: Patients  $\geq 40 - \leq 64$  years of age during the year of data collection
2. Elderly: Patients  $\geq 65$  years of age during the year of data collection



**Figure 12.** Flow chart for medical screening in dental settings



## **Data collection**

Data were collected through a self-administered written health declaration made before the dental appointment: age, weight, height, type and amount of tobacco use and medication to treat CVD and DM. Body mass index (BMI) was calculated and defined as an individual's body weight divided by the square of his or her height. Overweight was defined as a BMI value above 30.0 for men and above 28.6 for women.

## **Clinical examination**

After a five-minute rest in the dentist's examination chair in the examining room, using digital BP registration data about both systolic and diastolic BP and pulse were collected (68). The BP and pulse rate were measured by using a wrist device, an automatic sphygmomanometer NAIS DIAGNOSTEC EW 3002 (Matsushita Electric Works, Germany).

Plasma glucose was measured by means of a digital capillary blood sample, 3-3.5  $\mu$ L using a medical device, a glucometer called Roche Accu-Chek Compact (Roche Diagnostics GmbH, Roche Diabetes Care, D-68298 Mannheim, Germany). The device was independently and objectively evaluated (69).

Data collection for plasma glucose was not predominantly performed with fasting patients, which explains why the risk values determined rather than the diagnosis, were set by an experienced diabetes physician, Gunilla Hede of the Diabetes Centre, Karlstad Hospital, Sweden, with respect to the time lapsed since last consumed meal. For patients who had eaten during the past two hours, the value was set at 9.5 mmol/litre plasma and for those who not had eaten during the past two hours, the value was established at 8.0 mmol/litre plasma. For those fasting for the past eight hours, the cut-off value was set at 7.0 mmol/litre plasma (70).

The cut-off values for diastolic BP was set at 90 mm Hg or more, except for diabetics in which case the value was set at 85 mm Hg or more, generally 140 mm Hg or more for systolic BP. Patients who exceeded normal plasma glucose and diastolic BP values were referred to a medical doctor to have their values checked, possibly determine a diagnosis and initiate relevant therapy, or alternatively, receive health promotion advice (23).

All patients underwent clinical and radiographic examination performed by one of the clinic's two experienced and calibrated dentists who followed a detailed written protocol for data collection. These dentists have enjoyed a lengthy professional relationship, both in educational and clinical contexts, and daily discuss how to best measure and interpret clinical findings. Other categories of staff had been undergoing training specific to the medical screening project. The number of teeth was counted. Clinical periodontal status was assessed by recording bleeding on probing (BOP) and by probing the pocket depth on five predetermined teeth in each patient, tooth numbers 16, 21, 24, 41, 44 (71) using a periodontal probe, LM 23-520B Si with a 0.5 mm ball diameter tip (LM-Instruments Oy, Finland).

Pocket depth was measured on six surfaces of each selected tooth (distobuccal, midbuccal, mesiobuccal, mesiolingual, midlingual, distolingual) and expressed in mm as the distance between the gingival margin and the base of the periodontal pocket. Recordings of pocket depth and BOP were made on four surfaces (distal, buccal, mesial and lingual) on each measured tooth, choosing the deepest site on the measured approximal surface. Only a pocket depth of  $\geq 4$  mm was recorded.

### **Radiographic examination**

A radiographic examination of the periodontal status was undertaken on dentate patients and comprised of two or four bitewing x-rays using a standardized long-cone parallel technique, a routine examination as part of the yearly check-up visit (63). No bitewing x-rays were taken on patients with canine to canine small dentitions.

The marginal alveolar bone loss on bitewing radiographs was measured on each patient using a digital slide calliper from the cemento-enamel-junction (CEJ) to the crest of the alveolar bone on the approximal surfaces of canines, premolars and molars. A Mattson binocular with two-fold magnification was used to measure the mm distance from the CEJ to the alveolar bone crest. The distance was recorded and rounded off to the nearest 0.1 mm (0.05 rounded up). Marginal alveolar bone loss represents the mean distance of each patient. Radiographic readings were made in a randomly selected order twice by two independent readers, authors Göran Friman and Margareta Hultin. If the CEJ on an approximal surface could not be detected, the CEJ on the opposite surface of the same tooth or the neighbouring tooth was used as reference. Missing data or which the CEJ or marginal bone crest was undetectable, were specified as percentages of the total number of measured surfaces.

The agreement among examiners on radiographic readings was 90% and an analysis of the correspondence of the radiographic readings between the two examiners showed that the principal investigator (Göran Friman) measured the marginal bone loss to be a mean 0.1 mm less than the co-author and specialist in periodontology (Margareta Hultin).

### **Quartiles of clinical and radiographic periodontal status**

To evaluate variations of BP and plasma glucose in patients with varying clinical and radiographic periodontal status, partitions into quartiles were set on marginal alveolar bone loss, as well as the number and mean depth of periodontal pockets bleeding with a total registered pocket depth of  $\geq 4$  mm. Table 4 shows the partition into quartiles.

**Table 4.** Quartiles of clinical and radiographic periodontal status

Periodontal status	Lower quartile (q1)	Between lower and upper quartiles (q2)	Upper quartile (q3)
Number of pockets with depth $\geq$ 4 mm	0	$> 0 - < 3$	$\geq 3$
Mean depth of pockets $\geq$ 4 mm	0 mm	$> 0 - < 4.5$ mm	$\geq 4.5$ mm
Total mm of pocket depth $\geq$ 4 mm	0 mm	$> 0 - < 15$ mm	$\geq 15$ mm
Marginal alveolar bone loss	$< 2$ mm	$\geq 2 - < 3.4$ mm	$\geq 3.4$ mm

### Statistical Analysis

Statistical analyses were performed using the SPSS statistical software (Release 18.0.0 SPSS Inc., Chicago, IL). Potential correlations between periodontal status and systolic/diastolic BP were analyzed using Student's t-test, Spearman's rank correlation and Chi-Square Tests with a p-value  $< 0.05$  as significance level.

## 6.2 STUDY II

### Ethics Statement

The study is approved by the Regional ethical review board in Uppsala, Sweden, in accordance with the ethical standards and with the Helsinki Declaration of 1975, as revised in 1983. The participants received both verbal and written information about the study and that they were not compensated for their time, all of them gave their written informed consent to participate sent by post.

### Procedure

This qualitative study was based on individual interviews. It was conducted from March to May 2010 in a neutral venue not adjacent to the dental clinic in the town where the medical screening was performed.

Twenty-eight patients who underwent medical screening at the dental clinic in addition to their dental examination were asked in a personal letter to participate in an individual interview. They were selected strategically to maximize the variety of data in terms of age, gender, professional background and results of the medical screening.

The interviews were conducted by one of the authors (Awara Kalkali) with open-ended questions from an interview guide focusing on two main areas:

- How did the patients experience medical screening performed by dental professionals?
- How do the patients perceive regular medical screening when integrated into the regular dental examination?

The study process was inspired by Grounded Theory and the interviewees were asked to freely describe their experiences and opinions in conversational style (72). When necessary, the interviewer asked additional questions for clarification. The interviews lasted approximately 25-40 minutes and were audio taped and transcribed verbatim by another author (Ghazaleh Golestani). The transcription process was successively performed in the same order as the interviews. This procedure made it possible to check whether the interview guide or the interviews needed to be supplemented (72). After 17 interviews, the authors concluded that no new relevant information emerged, saturation was reached and the data collection ended (72).

### **Analysis**

As the study material did not have the prerequisites to entirely follow the Grounded Theory method, data was treated like a model similar to qualitative manifest and latent content analysis (73). The interview texts were read in their entirety by the authors and divided into groups of meaning-bearing units, codes. Similar codes were merged and then sorted into subcategories and categories. A comparison was made with the interview guide to see if the categories corresponded to the question areas. This represented the manifest level of analysis. Then the authors looked for a main category or a theme, the latent content analysis.

The analysis was illustrated with quotations. The quotes presented in this article are typical of the views expressed by the interviewees and are used to exemplify the categories and theme.

### **6.3 STUDY III**

Both quantitative and qualitative data were collected through a standardized questionnaire and subsequent interviews, but the study was mainly based on qualitative data (74).

The study was approved by the Regional Ethical Review Board in Uppsala, Sweden, in accordance with the ethical standards and with the Helsinki Declaration of 1975, as revised in 1983. The participants received both verbal and written information about the study, they were not compensated for their time, and their participation was completely voluntary.

## Study setting and population

Through a purposive sampling (75), twenty Swedish authorities and organizations were contacted. The research team initially sought contact with the chairman, vice chairman or spokesperson. If none of these chief persons were able to respond or were unavailable for an interview, another representative was requested as respondent. The research team considered the selection to be relevant to meet the purpose of the study. Thirteen participating authorities and organizations took part in the study and are described in Table 5.

**Table 5.** Swedish authorities and organizations that took part in the study

Authorities	Organizations
The Dental Board of the County Council of Värmland ( <i>Tandvårdsnämnden, Landstinget i Värmland</i> )	The Swedish Medical Association ( <i>Sveriges Läkarförbund</i> ) The Swedish Association of Dental Hygienists ( <i>Sveriges Tandhygienistförening</i> ) Swedish Dental Nursing Association ( <i>Svenska Tandsköterskeförbundet</i> ) The Swedish Association of Health Professionals ( <i>Vårdförbundet</i> ) The Uppsala Dental Service Organisation ( <i>Folk tandvårdsföreningen, Folk tandvårdens kansli Uppsala</i> ) Praktikertjänst AB SKL - Swedish Association of Local Authorities and Regions ( <i>SKL –Sveriges kommuner och landsting</i> ) Swedish Diabetes Association ( <i>Svenska diabetesförbundet</i> ) The Swedish Stroke Association ( <i>STROKE-Riksförbundet</i> ) Faculty of Odontology at Malmö University Institute of Odontology, The Sahlgrenska Academy, Gothenburg Department of Dental Medicine, Karolinska Institute, Huddinge

The Swedish names of authorities and organizations given in parentheses

The selected authorities and organizations were contacted primarily by phone and those who gave consent to take part in the study got an email with further information and a questionnaire.

## Data collection

Of the twenty purposive sampled Swedish authorities and organizations, there were seven dropouts. The reasons given for not participating were: not taken a position on the issue, not relevant instance, and not suitable as they work exclusively with issues regarding primary

and secondary education. One respondent did not reply. Thirteen Swedish authorities and organizations constituted the final study material.

All respondents received a standardized questionnaire with eighteen questions concerning medical screening in dental settings to gain insight into the topic and prepare for an interview, as they were mainly supposed to express positive and negative opinions that characterized their authority or organization and not personal thoughts. The questionnaire design was first evaluated in a pilot study involving ten selected teachers at the Department of Dental Medicine, Karolinska Institutet, Huddinge. Using a traditional four-point Likert scale, respondents indicated to what degree a statement was consistent with their opinion by stating “Strongly disagree”, “Disagree”, “Agree” or “Strongly agree” (76).

Qualitative data were collected through interviews by two trained calibrated interviewers with thirteen open-ended questions from an interview guide that addressed the relevant topics (Table 6). The guide was tested on a pilot person to optimize the questions and to get as comprehensive answers as possible. Each open-ended question had follow-up questions so as to, if possible, achieve saturation. The main portion of the interviews was conducted by phone and the rest during personal appointments at offices of the authorities and organizations from December 2012 to April 2013.

**Table 6.** Interview guide

---

Issues
Territorial mentality
Voluntariness of the patients, the dental care and the health care
Patient’s perspective, integrity, confidentiality, availability, quality of life
Quality of care and caring responsibilities
Competence, the lowest level of care for risk assessment
Education and qualifications
Economics
Legal affairs

---

Each interview lasted approximately 40 minutes and was audio-recorded and transcribed verbatim. After thirteen interviews, the authors concluded that no new relevant information emerged, saturation was reached and the data collection ended (73).

### **Data analysis**

The qualitative data were analyzed with qualitative manifest and latent content analysis (73). The interview texts were read in their entirety, discussed by the authors and divided into groups of meaning-bearing units, codes. Similar codes were merged and then sorted

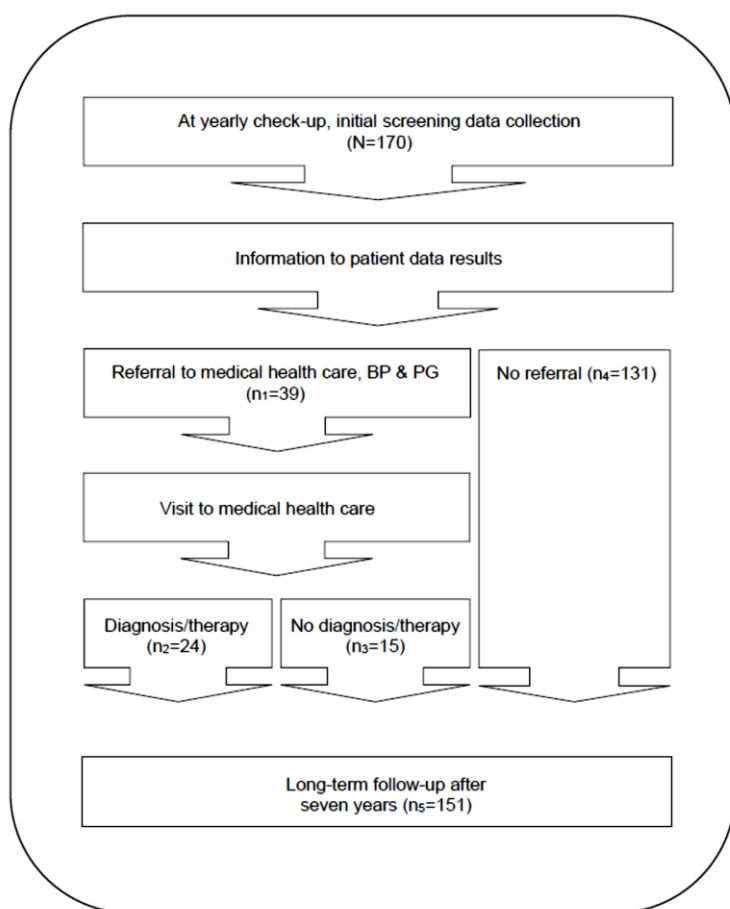
into subcategories and categories. A comparison was made with the interview guide to see if the categories corresponded to the question areas. This represented the manifest level of analysis. The authors then looked for a main category or an underlying theme, the latent content analysis. The qualitative results were illustrated with quotations. The quotes presented were expressed by the interviewees and were used to exemplify the categories and theme.

## 6.4 STUDY IV

### Design and setting

The study had a descriptive design of a non-random sample of consecutively included patients, with a longitudinal perspective.

The study was performed in an everyday private dental setting in a small town in mid-Sweden in 2004 and 2011. All regular patients generally underwent an annual dental examination performed by a dentist. One hundred seventy patients agreed to participate in the initial screening project (Figure 13) (38).



**Figure 13.** Flow chart for the initial screening and follow-up. Patients who exceeded normal PG and diastolic BP values were referred to medical healthcare to have their values checked ( $n_1=39$ ). Of those referred, 24 received medical treatment ( $n_2=24$ ) and 15 did not ( $n_3=15$ ). One hundred thirty-one patients were deemed to not be at risk ( $n_4=131$ ).

## **Data collection**

### *Initial screening*

Data were collected through a self-administered written health declaration made before a dental appointment: age, weight, height, type and amount of tobacco use, and pharmacological treatments of CVD and DM. Body mass index (BMI) was calculated and defined as an individual's body weight divided by the square of his or her height (38).

After a five-minute rest in the dentist's examination chair in the examining room, data about systolic and diastolic BP and pulse were collected using a digital wrist device. PG was measured by means of a digital capillary blood sample, 3-3.5  $\mu$ L, using a glucometer.

### **Follow-up**

The same written health declaration used at the study start was repeated in 2011. The health declaration was sent to the patients by post along with written information about the study. The questionnaire was returned in a postage-paid envelope or was collected by telephone. In those cases where patients had died, permission was requested from relatives to examine the deceased's pharmacological treatment and possible cause of death.

### **Definitions of risk levels**

In the initial screening, the cut-off value for diastolic BP was set at 90 mm Hg or more, except for diabetics, in which case the value was set at 85 mm Hg or more, and generally 140 mm Hg or more for systolic BP. Patients who exceeded normal plasma glucose and diastolic BP values were referred to medical care to have their values checked, possibly determine a diagnosis and initiate relevant treatment. The inclusion criteria for being a risk patient for HT was diastolic BP, but in the present paper we also chose to explore the health development among those who had a systolic BP above 140, 160 and 180.

The cut-off values for PG in the initial screening were dependent on the patient's most recent food intake. For patients who had eaten during the past two hours, the value for suspected pathological plasma glucose was set at 9.5 mmol/litre plasma and for those who not had eaten during the past two hours, the value was established at 8.0 mmol/ litre plasma. For those fasting for the past eight hours, the cut-off value was set at 7.0 mmol/litre plasma.

### **Outcome measures**

In the follow-up, measures were:

- number of study participants who had passed away during the seven-year period
- insertion of antidiabetics or antihypertensives during the seven-year period
- changes in weight and height to calculate BMI



### **Statistical analysis**

Statistical analyses were performed using the SPSS statistical software (Release 22.0.0 SPSS Inc., Chicago, IL). Potential changes in the study material were analysed using Student's t-test for dependent samples and the McNemar Test. Student's t-test for independent samples and the Mann Whitney U test were used for comparisons between pharmacological treatment groups. Risk analyses were conducted using univariable logistic regression and results were expressed as odds ratios (OR) with 95% confidence intervals (CI). A p-value < 0.05 was considered to be statistically significant.

### **Ethics Statement**

The study was approved by the Regional Ethical Review Board in Uppsala, Sweden, in accordance with the ethical standards and with the Helsinki Declaration of 1975. The participants received written information about the study, were not compensated for their time, and their participation was voluntary.

## 7 RESULTS

### 7.1 STUDY I

#### Background data

Of the 207 consecutively invited patients, 170 were recruited at their recalls for regular yearly check-up visits. The dropout rate was 17.9%, with the main explanations for not participating “no special reason” or “have regular medical care contact”. Other common reasons were “long distance for any sampling” and “do not want to know about an undiagnosed illness”. Rare frequent reasons included “don’t want” and “have given lab-samples elsewhere”.

The mean age was 63.95 years (SD 12.4) ranging from 40 to 88, with more women (94) than men (76) participating. Two patients (1.2%) were edentulous and 31 patients (18.2%) were overweight according to their BMI values.

#### Plasma glucose and blood pressure

Of the 170 participating patients, 39 were referred to a medical doctor due to high diastolic values and/or high plasma glucose levels at their screenings. Ten of these 39 patients exhibited plasma glucose values beyond the cut-off level, fasting glucose >7.0 millimoles per litre (mmol/l) or values in excess of levels adjusted to elapsed time since their last meals. Four of these ten required further care according to the medical physician conducting their examinations. The correlation between oral health care and medical care in recording plasma glucose was 40.0% ( $p < 0.001$ ).

Thirty-one of the 39 who were referred exhibited diastolic BP beyond the cut-off level at the screenings. Twenty of these 31 patients who exceeded normal diastolic blood pressure required further care according to the examining medical physician. The correlation between oral health care and medical care in recording blood pressure was 64.5% ( $p < 0.001$ ). Three of these 20 also required further care caused by high plasma glucose, which demonstrates the close relation between high BP and high plasma glucose. We found systolic BP significant correlated to plasma glucose ( $p = 0.005$ ).

Consequently, 24 (61.5%) out of the 39 referred patients required additional care ( $p < 0.001$ ). For further general and medical-related background data and periodontal status, please see Tables 7 and 8. Eighty-eight of the 170 patients had systolic BP beyond the cut-off level.

**Table 7.** General and related medical background data

	Total N=170 (100 %)		Middle-aged n=90 (52.9%)		Elderly n=80 (47.1%)	
	Total	Men/ Women	Total	Men/ Women	Total	Men/ Women
Total	170	76/94	90	42/48	80	34/46
% in group		44.7/55.3		46.7/53.3		42.5/57.5
Mean BMI	26.3	26.6/26.1	27.0	27.8/26.3	25.6	25.1/25.9
Overweight BMI	31	13/18	21	11/10	10	2/8
% in group	18.2	17.1/19.1	23.3	26.2/20.8	12.5	5.9/17.4
Smokers	23	10/13	19	8/11	4	2/2
% in group	13.5	13.2/13.8	21.1	19.0/22.9	5.0	5.9/4.3
Smoked 6 or more cigarettes/day	17	6/11	16	6/10	1	0/1
% in group	10.0	7.9/11.7	17.8	14.3/20.8	1.3	0/2.2
Medication for CVD. anti- hypertension	59	25/34	18	8/10	41	17/24
% within group	34.7	32.9/36.2	20.0	19.0/20.8	51.3	50.0/52.2
Medication for diabetes mellitus	12	9/3	5	4/1	7	5/2
% in group	7.1	11.8/3.2	5.6	9.5/2.1	8.8	14.7/4.3
Mean pulse rate	69.3	69.1/69.4	70.2	70.9/69.6	68.3	67.0/69.2

One individual medicated for low BP

**Table 8.** Periodontal status

		Clinical periodontal status									Radiographic periodontal status			Total dentated (Total x-rayed)	
		Number of pockets with depth $\geq 4$ mm			Mean pocket depth $\geq 4$ mm			Total mm of registered pocket depth $\geq 4$ mm			Marginal alveolar bone loss				
Quartiles		q1	q2	q3	q1	q2	q3	q1	q2	q3	q1	q2	q3		
< 65 years	Men	Count	9	15	18	8	19	15	8	21	13	17	21	3	42 (41)
		% in sex	21.4	37.5	42.9	19.0	45.2	35.7	19.0	50.0	31.0	41.5	51.2	7.3	100.0
< 65 years	Women	Count	16	13	19	16	19	13	16	18	14	13	26	7	48 (46)
		% in sex	33.3	27.1	39.6	33.3	39.6	27.1	33.3	37.5	29.2	28.3	56.5	15.2	100.0
	Total	Count	25	28	37	24	38	28	24	39	27	30	47	10	90 (87)
		% in age group	27.8	31.1	41.1	26.7	42.2	31.1	26.7	43.3	30.0	34.5	54.0	11.5	100.0
>= 65 years	Men	Count	14	10	9	14	11	8	14	13	6	3	10	16	33 (29)
		% in sex	42.4	30.3	27.3	42.4	33.3	24.2	42.4	39.4	18.2	10.3	34.5	55.2	100.0
>= 65 years	Women	Count	20	16	9	20	17	8	20	16	9	8	17	13	45 (38)
		% in sex	44.4	35.6	20.0	44.4	37.8	17.8	44.4	35.6	20.0	21.1	44.7	34.2	100.0
	Total	Count	34	26	18	34	28	16	34	29	15	11	27	29	78 (67)
		% in age group	43.6	33.3	23.1	43.6	35.9	20.5	43.6	37.2	19.2	16.4	40.3	43.3	100.0

**Clinical periodontal status and number of teeth**

The correlations between the number of pockets with depth of  $\geq 4$  mm, mean depth  $\geq 4$  mm and total mm pocket depth  $\geq 4$  mm were significant ( $p < 0.001$ ). These clinical periodontal status parameters are presented below as data of the number of pockets with depth of  $\geq 4$  mm.

When all subjects had been analyzed, we found no significant correlations between the number of teeth or the clinical periodontal status and diastolic BP. Three out of four subjects with diastolic BP above the cut-off level (90 mm Hg; 85 mm Hg for patients with diagnosed DM) had pockets with a depth of  $\geq 4$  mm, and 14 of the 31 subjects (45.2%) with diastolic BP above the cut-off level had  $\geq 3$  pockets with a depth of  $\geq 4$  mm. Please see Table 9 for correlations between blood pressure, plasma glucose (PG) and periodontal status.

**Table 9.** Correlation between blood pressure, plasma glucose and periodontal status

	Quartiles	Diastolic BP < 90 (< 85)	Diastolic BP ≥ 90 (85)	Systolic BP < 140	Systolic BP ≥ 140	PG below cut-off level (non- DM medication)	PG beyond cut-off level (non- DM medication)
<b>Number of teeth</b>	≤ 20 teeth	48	9	20	37	54 (55)	3 (2)
	% in BP & PG group	34.5	29.0	24.4	42.0	33.8 (33.7)	30.0 (28.6)
	> 20 teeth	91	22	62	51	106 (108)	7 (5)
	% in BP & PG group	65.5	71	75.6	58.0	66.3 (66.3)	70.0 (71.4)
<b>Number of pockets ≥ 4mm with PD of ≥ 4mm</b>	q1	51	8	27	32	54 (57)	5 (2)
	% in BP & PG group	37.2	25.8	32.9	37.2	34.2 (35.4)	50.0 (28.6)
	q2	45	9	22	32	53 (53)	1 (1)
	% in BP & PG group	32.8	29.0	26.8	37.2	33.5 (32.9)	10.0 (14.3)
	q3	41	<b>14</b>	33	22	51 (51)	4 (4)
	% in BP & PG group	29.9	<b>45.2</b>	40.2	25.6	32.3 (31.7)	40.0 ( <b>57.1</b> )
<b>Mean pocket depth ≥ 4mm</b>	q1	50	8	27	31	54 (56)	4 (2)
	% in BP & PG group	36.5	25.8	32.9	36.0	34.2 (34.8)	40.0 (28.6)
	q2	55	11	31	35	63 (64)	3 (2)
	% in BP & PG group	40.1	35.5	37.8	40.7	39.9 (39.8)	30.0 (28.6)
	q3	32	12	24	20	41 (41)	3 (3)
	% in BP & PG group	23.4	38.7	29.3	23.3	25.9 (25.5)	30.0 ( <b>42.9</b> )
<b>Total mm of registered PD of ≥ 4 mm</b>	q1	50	8	27	31	54 (56)	4 (2)
	% in BP & PG group	36.5	25.8	32.9	36.0	34.2 (34.8)	40.0 (28.6)
	q2	54	14	29	39	65 (66)	3 (2)
	% in BP & PG group	39.4	45.2	35.4	45.3	41.1 (41.0)	30.0 (28.6)
	q3	33	9	26	16	39 (39)	3 (3)
	% in BP & PG group	24.1	29.0	31.7	18.6	24.7 (24.2)	30.0 ( <b>42.9</b> )
<b>Marginal alveolar bone</b>	q1	35	6	25	16	41 (41)	0 (0)
	% in BP & PG group	27.8	21.4	31.6	21.3	28.5 (27.9)	0 (0)
	q2	62	12	42	32	69 (71)	5 (3)
	% in BP & PG group	49.2	42.9	53.2	42.7	47.9 (48.3)	50.0 ( <b>42.9</b> )
	q3	29	10	12	27	34 (35)	5 (4)
	% in BP & PG group	23.0	35.7	15.2	36.0	23.6 (23.8)	50.0 ( <b>57.1</b> )

There were significant correlations between the number of teeth and systolic BP ( $p=0.015$ ) as well as medication to alleviate CVD ( $p=0.005$  and non-parametric correlation  $p<0.001$ ), but no correlation was found between the number of teeth and clinical periodontal status. The correlation between plasma glucose and clinical periodontal status displayed no significance, but 57.1% of those subjects who exhibited plasma glucose above the cut-off level and who were not on medication for DM had  $\geq 3$  pockets with a depth of  $\geq 4$  mm.

### **Radiographic periodontal status**

In 16 cases (9.4%), it was not at all possible to measure the marginal alveolar bone loss on x-ray owing to their being edentulous, having small dentitions or a total lack of reference points on x-rays: among middle-aged subjects 3.3% and among elderly subjects 16.3% fell into this category. The mean for missing data was 20.3% of the 154 cases under study; among middle-aged subjects the mean was 10.8% and among elderly subjects, the mean for missing data was 32.8%.

There was no significant correlation between plasma glucose and radiographic periodontal status, but all subjects who displayed plasma glucose above the cut-off level exhibited marginal alveolar bone loss  $> 2$  mm, and 57.1% of the members of this group who were not on medications for DM had  $\geq 3.4$  mm.

One hundred thirteen of the 154 dental patients (73.4%) had radiographic marginal alveolar bone loss of  $\geq 2$  mm according to the distribution in Table 3. The mean bone loss of middle-aged subjects was 2.4 mm (SD 0.9) and in elderly subjects 3.2 mm (SD 1.2).

In analyzing all patients, no significant correlations were discovered between marginal alveolar bone loss and diastolic BP. Four of five subjects with diastolic BP above the cut-off value showed marginal alveolar bone loss of  $\geq 2$  mm. Of these 113 with  $\geq 2$  mm, 22 (19.5%) had screened diastolic BP above the cut-off value, as compared with six patients (14.6%) of 41 with a bone loss of  $< 2$  mm. There was no correlation between marginal alveolar bone loss ( $p=0.07$ ) and taking medication to alleviate CVD.

However, there was both a significant correlation ( $p<0.001$ ) and a significant non-parametric correlation ( $p=0.001$ ) between systolic BP and marginal alveolar bone loss. Twenty-seven patients out of a group of 39 (69.2%) with a bone loss of  $\geq 3.4$  mm showed systolic BP  $> 140$  mm Hg. The correlation was stronger for men ( $p=0.001$ ) than for women ( $p=0.038$ ) and there was also a significant non-parametric correlation ( $p=0.008$  and  $p=0.049$ , respectively). Furthermore, significant correlations for middle-aged ( $p=0.039$ ) and elderly ( $p=0.029$ ) subjects were also discovered. After controlling for age and sex, significant correlations between systolic BP and marginal alveolar bone loss remained among middle-aged men ( $p=0.036$ ), while no such correlations were found among women.

Among elderly women, there was a significant correlation between marginal alveolar bone loss and clinical periodontal status ( $p=0.014$ ), while a bone loss of  $\geq 2$  mm was less frequent among non-smokers than among smokers.

## Age

An analysis of all patients showed significant correlations between age and medication for CVD ( $p<0.001$ ), diastolic BP ( $p=0.009$ ), systolic BP ( $p<0.001$ ), marginal alveolar bone loss ( $p<0.001$ ), missing radiographic data ( $p<0.001$ ) and clinical periodontal status ( $p=0.002$ ). There were significant correlations between age and clinical periodontal status among non-smokers ( $p=0.016$ ) and men ( $p=0.007$ ), whereas no such correlations were discovered among smokers and women.

## 7.2 STUDY II

Of the 28 selected potential interviewees, 19 agreed to participate. The reasons for not participating were: three were “out of town”, three “forgot how the screening was conducted” and three did not reply. Two of the participants then failed to appear for the agreed interview: one had decided not to participate in the study and the other failed to appear for the interview and then could not be reached either by phone or letter. Seventeen patients were ultimately interviewed (Table 10).

**Table 10.** Characteristics of study material. Values are number of participants if not otherwise stated.

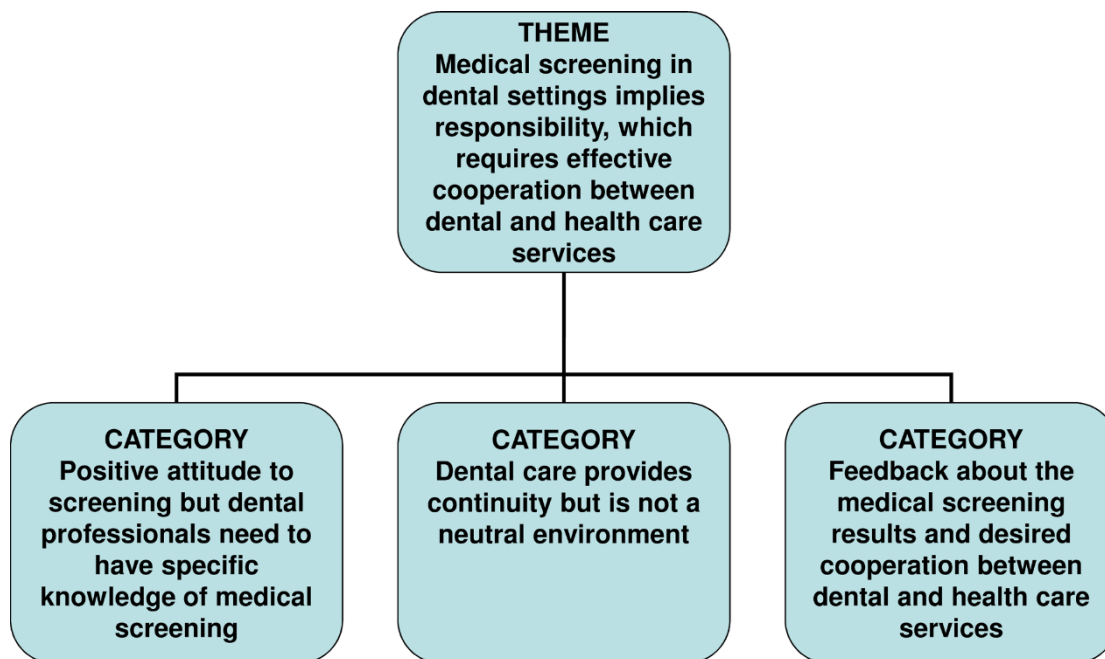
Study material	Medical screening N (%)	Interview n (%)
Samples	207	28
Dropouts	37	11
Participants	<b>170 (100)</b>	<b>17 (100)</b>
Men	76 (44.7)	9 (52.9)
Women	94 (55.3)	8 (47.1)
Mean age	63.95	66.05
Referred for health care	40 (23.5)	7 (41.2)
Required health care or lifestyle recommendations	23 (13.5)	4 (23.5)

Meaning-bearing units were extracted from the texts, and codes, subcategories and categories were formed (Table 11). Figure 14 gives a visual presentation of the findings. The analysis revealed three categories made up of a number of subcategories. One theme permeated them all. Below, these results are presented in greater detail.

**Table 11.** Examples of meaning-bearing units, codes, subcategories and categories.

Codes	Subcategory	Category
<i>Codes and subcategories describing the category “Positive attitude to screening but dental professionals need to have specific knowledge of medical screening”</i>		
Positive view on screening Prevent potential noncommunicable diseases Insight into a possible link between general and oral health	Positive attitude to screening	Positive attitude to screening but dental professionals need to have specific knowledge of medical screening
Equal sampling standard by health care as by dental professionals Similar education and training Requires proper knowledge	Professional skills in medical screening	
Prepared to pay the same for the service	Willingness to pay	
<i>Codes and subcategories describing the category “Dental care provides continuity but is not a neutral environment”</i>		
Dental regularity and continuity Different doctors, usually the same dental professional Reluctance to seek medical attention	Dental care provides continuity	Dental care provides continuity but is not a neutral environment
White coat hypertension Dental fear	Risk of erroneously high blood pressure in the dental environment	
<i>Codes and subcategories describing the category “Feedback about the medical screening results and desired cooperation between dental and health care services”</i>		
Getting a response about their health	Feedback about the medical screening results	Feedback about the medical screening results and desired cooperation between dental and health care services
The dental care service becomes a link Referral to health care Collaboration or integration between dental and health care Dental professional cannot make a medical diagnosis	Integrated dental and health care	





**Figure 14.** Patient experiences of medical screening performed by the dental care service, as described in three categories and one theme.

### Manifest Analysis

#### *Positive attitude to screening but dental professionals need to have specific knowledge of medical screening*

This category included the subcategories “positive attitude to screening”, “professional skills in medical screening” and “willingness to pay”.

All interviewees had positive thoughts and opinions about undergoing medical screening at a dental clinic. Some also had some insight into a possible relationship between general health and oral health, which made them even more interested in a screening.

*It's good that the dentist does a medical screening since there may be a relationship between the two. And I guess there's something to the idea that teeth and things affect the rest of one's body. If medical screening can prevent diseases and injuries in time, that's definitely an advantage.*

The interviewees felt it was important for the dental care staff to have adequate knowledge if they were going to do medical screening, and also stated that there was no difference between dental and health care staff when it came to the practical performance of the screening.

*Actually, I thought they were just as professional as at the doctor's office. I didn't experience any difference. In my opinion, he has, I guess, as I see it, they are basically trained in similar ways.*

The interviewees were willing to pay for this service. Since they paid at the health care service, they could just as well pay the same at the dental care service.

*I don't mind paying, since I uh, go to the health center and then I have to go there. And pay for it. So uh, if the price is the same.*

### ***Dental care provides continuity but is not a neutral environment***

This category included the subcategories “dental care provides continuity” and “risk of erroneously high blood pressure in the dental environment”.

Many interviewees remarked that they go to their dentist yearly, and usually see the same dentist, so they go there more often than to the doctor, which made medical screening by the dental service seem convenient.

*You always see a different doctor, but usually the same dentist. I think lots of people go to the dentist more regularly than to the doctor.*

The advantages of dental regularity and continuity were stressed by several interviewees, who pointed out that some people are reluctant to seek medical attention. They neglect their symptoms. Dental care can help identify patients at risk with this screening.

*I go to the dentist more often than the doctor. So this is a good way for me to get checked, you might say.*

*On the other hand, I would be glad to have it discovered in time because then I would actually be able to do something about it.*

Some of the interviewees mentioned that it was important for the dental services to consider source of error in blood pressure sampling. They pointed out an uncertainty in pressure measurement when they had a high value at the clinic but a normal value when their blood pressure was taken at home or after rest at the health center. Some interviewees could not remember any period of rest before their blood pressure was taken, but said that it was just the same as at the doctor's office.

*When they take your blood pressure when you are there to see the dentist and are a little nervous, then it will be higher. That's a natural reaction. In fact it always goes up when you are the dentist's or the doctor's office. It would go up a little bit in any case.*

### ***Feedback about the medical screening results and desired cooperation between dental and health care services***

This category included the subcategories “feedback about the medical screening result”, and “integrated dental and health care”.

The interviewees emphasized the importance of getting a response about their health through feedback after the screening. They pointed out that if medical screening were included in the annual dental appointment, it would be important to receive feedback.

*Well, nothing happened afterwards. So I think that was one thing, getting no follow-up. I don't know what happened. If I had had high blood glucose I don't know if there would have been follow-up, either.*

It was not clear to everyone as to whether there was established collaboration between the dental and health care services. Therefore, many interviewees pointed out such collaboration needed to be established before medical screening in dental settings could be introduced, and they even suggested integration between dental and health care.

*I don't really understand why there is a distinction between the health care and dental services.*

If plasma glucose and blood pressure are checked by the dental care services, this should certainly make things easier for the health care staff and if necessary, the dental care service can send a referral to health care so the patient gets a new health care contact. In other words, the dental care services become a link. The interviewees considered that close collaboration was especially beneficial when disease symptoms are neglected.

*Well, I think I'd get help faster with a referral. It would be sent to my doctor, like. Which would make things happen better than if I tried to work it out myself.*

*I'd see it as a good thing if they sent a referral – directly... of course there may be people who... would rather themselves ... make the contact but I don't see ... any disadvantage about it.*

Not all but most of the interviewees were aware that the dental care services cannot make a medical diagnosis.

## Latent analysis

### *Medical screening in dental settings implies responsibility, which requires effective cooperation between the dental and health care services*

The latent analysis revealed that introducing medical screening in a dental care setting is a responsibility that requires good collaboration between the dental and health care services. Some interviewees in this project felt that the collaboration was not completely clear to them.

When the patient's screening values exceeded thresholds for disease risk, these at-risk patients would have the opportunity, if the dental care service referred them to the health care service, to receive health care earlier without having to contact the health care service themselves. The referral would result in a smoother and easier handling of their cases. However, it was important to the interviewees to experience the procedure as being carried out properly and safely.

Some interviewees pointed out a feeling of insecurity in the lack of feedback and information about their test results. Many felt that they were not informed whether they had elevated values. All interviewees requested clear feedback if a medical screening were to be introduced in the dental care. Others realized that they probably would have been notified if they were at risk of disease.

*When they did the diabetes test I thought, uh, well, if they found anything I do hope they would call and tell me. Yes, and that there has to be a link to the health centre or something. With the dentist.*

Finding out that you are at risk of disease or possibly already have a disease was not negative, according to the interviewees. They all felt it didn't matter whether this information came from the dental or medical services. The most important thing was that they found out. All interviewees realized that medical screening could lead to early disease detection.

*There can't be anything negative about finding out that you're sick.*

The attitude of the interviewees to the dental care services taking responsibility for their general health was positive, and they pointed out benefits of undergoing medical screening at the dentist's office. However, one person out of the seventeen felt that this was not the responsibility of the dental service.

### 7.3 STUDY III

#### The quantitative data

The quantitative data was analyzed descriptively. The answers on the eighteen items resulted in 46% (108) positive responses to medical screening in dental settings, 41% (95) negative responses and 13% (31) non-responses.

#### The qualitative data

Meaning-bearing units were extracted from the texts, and subcategories and categories were formed (Table 12). Figure 15 gives a visual presentation of the findings. The analysis revealed four categories made up of nine subcategories. One theme permeated them all. Below, these results are presented in greater detail with citations.

**Table 12.** Summary of subcategories and categories

Subcategory	Category
Dentistry as the preferable context to perform medical screening in the society A need for evidence-based medical screening in the society	Medical screening ought to be established in the society
Dental hygienists and dental nurses are the most relevant professions to perform medical screening Dental care requires supplemented competence and national guidelines to perform medical screening Essential competence could preferably be obtained through postgraduate studies	Dentistry must have relevant competence to perform medical screening
Medical screening requires a responsibility to inform and direct the patient but not to follow up general diseases Medical screening initiates and improves the cooperation between dental and health care	Medical screening requires cooperation between dentistry and health care
Equal costs for the patient wherever medical screening is performed Optional to provide medical screening in dental settings	Dentistry is not the only context where medical screening could be performed



**Figure 15.** Graphical presentation of the descriptive content analysis, subcategories, categories and theme

## **Manifest descriptive content analysis**

### ***Medical screening ought to be established in the society***

#### **Dentistry as the preferable context to perform medical screening in the society**

The majority of the participants pointed out the importance of medical screening as a community-promoting action. They argued that dental care should take that responsibility, due to the fact that dental care follows its patients more frequently on a regular basis in comparison with health care.

*Because we can see basically the entire healthy population fairly regularly in dental care, it can be an advantage to identify a number of illnesses that could take a while to diagnose. For these, it could be a great advantage if this were the case.*

Those who were more reluctant stressed the difficulties of making an overall assessment and identifying at-risk individuals. A lack of resources in dentistry, skills shortages and sources of error in procedural techniques were mentioned as stumbling blocks. Territorial thinking was

also highlighted as a possible problem. The predominant portion of participants, however, agreed that these problems could be overcome through increased competence.

*... it's still health care that owns this issue. So it has to be done in very close collaboration with health care, so that there is a, um, big picture for the patient.*

#### A need for evidence-based medical screening in the society

A minor portion of the participants answered that medical screening was needed in our society, but stressed the need for common guidelines concerning competence, skills and patient management. The lack of evidence was also the main reason for not looking upon medical screening as something valuable. A few participants considered the need not equivalent to the cost.

#### ***Dentistry must have relevant competence to perform medical screening***

#### Dental hygienists and dental nurses are the most relevant professions to perform medical screening

Most participants made the judgment that dental care has the personnel to implement medical screening. Dental hygienists or dental nurses were considered to be the most suitable personnel group for the performance of medical screening in dental settings. Medical screening can be a natural part of the hygienist's health conversation with their patients. Some participants argued that there is already a shortage of capacity in dentistry and the possible introduction of medical screening means increased need for resources.

*I think that we can develop the skills of a category of personnel in dentistry to perform this. A dental hygienist can be responsible for this after further training.*

#### Dental care requires supplemented competence and national guidelines to perform medical screening

The majority of the participants answered that there was insufficient expertise in dental care to perform medical screening and that competence needed to be supplemented. Other participants clarified their answer by saying that dental care was capable of performing the investigations but lacked the skills to interpret the test results. One association brought up the opinion that dental care did not need specific regulations to govern the conduct of medical screening. There are already regulations and national guidelines in place to regulate various types of screening, but not specific regulations and guidelines for medical screening in dental settings, which would be demanded.

*Yes, I think that you can probably always in these situations have some form of regulations and guidelines. I think that you should have these, because otherwise you can't perform medical screening if it's not regulated in some way.*

### Essential competence could preferably be obtained through postgraduate studies

Most participants agreed that basic education for both dentists and dental hygienists already contained a lot and that there was no space for new topics; however the competence could be obtained through postgraduate studies. One of the participants felt that the practical part should be during dental hygienists' undergraduate studies. Others advocated a combination of undergraduate and postgraduate studies.

*Competence could be increased in undergraduate studies, because all higher education should be adapted to potential future conditions. This knowledge could also be acquired in continuing education.*

### ***Medical screening requires cooperation between dentistry and health care***

#### Medical screening requires a responsibility to inform and direct the patient but not to follow up general diseases

The participants agreed that dental care had the mission to identify patients at risk and the responsibility to inform the patient about the screening results, whether they were at risk of a medical disease or not, while emphasizing that dental care is not able to make medical diagnoses of general diseases. Dental care has an obligation to follow up the patient to a certain extent. That is, possibly referring the patient or recommending her to seek health care, and the follow-up should rest with health care. A necessity for effective cooperation is professional communication, through referrals.

*Yes, following up on the patient is a must. You have to refer the patient for further treatment. This requires good collaboration with primary care.*

*... this assumes that there is a good communication between dentistry and health care so that the patient can be referred or transferred over to health care... The responsibility for continued care must lie with health care!*

#### Medical screening initiates and improves the cooperation between dental and health care

The overwhelming majority of the participants answered that cooperation between dental and health care would improve health-promotion measures not only for the patients but also for society. The cooperation provides opportunities for evaluation of the at-risk groups who need to be screened, cut-off levels and referral management, and clear guidelines for implementation and communication. Misjudgments of sample values may result in increased workload for health care, a risk that can be reduced or possibly eliminated by collaboration.



*Yes, this would certainly mean a greater workload when patients are referred who are not sick.*

*Yes, I would really like it if we could cooperate ... there are only benefits to be gained by all of this, that's for sure ...*

### ***Dentistry is not the only context where medical screening could be performed***

#### Equal costs for the patient wherever medical screening is performed

Concerning costs, the participants responded very evenly. The participants said that it was a difficult question to talk about because the benefit of medical screening was not scientifically documented yet, as far as they were aware. But it was judged to be fair to the patient to pay the same amount regardless of whether dental or health care performed a screening.

*No, I think that the prerequisite for implementation of this is that there are no increased costs for the patient.*

#### Optional to provide medical screening in dental settings

To the question of whether all dental settings should provide medical screening, just over half of the participants considered that there must be a care package that is optional and set by each individual dental clinic depending on the clinic's interest. The remaining participants considered that all dental clinics should introduce medical screening. Introduction must be widespread to have a clear public health effect. The impact would not be as effective if medical screening did not reach out to the entire population.

*In a dream world, I would say of course, but I know that they won't do it because not everyone is interested in this.*

### **Latent content analysis – theme**

#### ***Positive to, but uncertain about the concept of medical screening in dental settings***

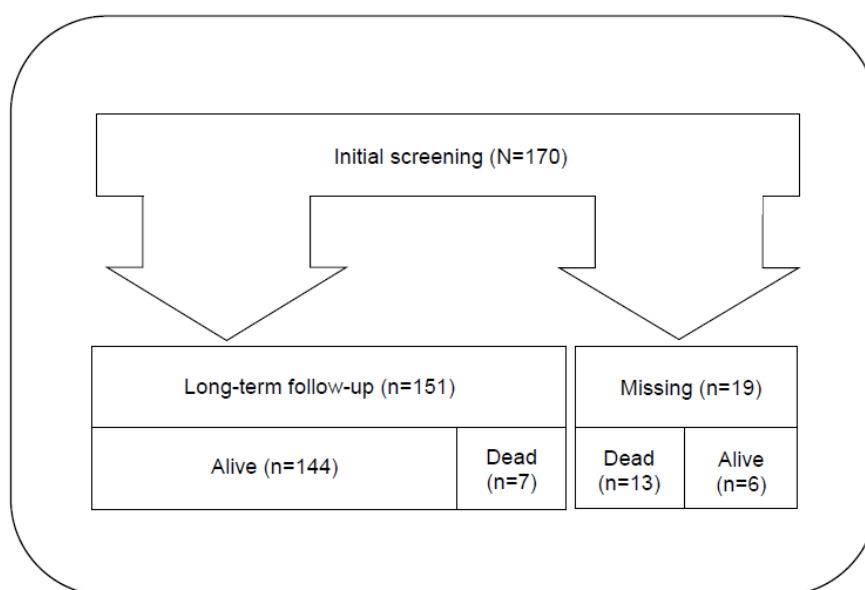
Approached authorities and organizations generally had a positive view of medical screening in dental settings but the responding spokespersons were uncertain about the concept, because they experienced a lack of facts concerning the scientific knowledge position, guidelines and procedures in the topic (Figure 15).

*... it must be based on what existing scientific evidence there is for medical screening actually reducing disease in the population and contributing to overall health. In other words, it must be based on existing medical screening actually having a positive effect, and if it does, well then it is obvious there should be clear rules governing it ... Just like all women of a certain age are offered mammograms!*

## 7.4 STUDY IV

### Background data

Of the included 170 participants (Figure 13), 151 (88.8%) finally participated in the seven-year follow-up, a dropout of 11.2% (Figure 16). Six choose not to attend the follow-up and it was not possible to collect medical data from 13 of the 20 participants who had passed away. Six of these 20 patients were among those who were referred to healthcare in the initial screening (15.4% 6/39) and 14 were among the non-referred patients (10.7% 14/131). At the initial screening, the mean age was 63.95 years, range 40-88 years, and at the follow-up, the mean age was 69.12 years, range 47-94 years.



**Figure 16.** Background data

### Hypertension

#### *Diagnosis and treatment*

Of the 170 participants in the initial screening, 39 were referred to medical care for suspected high BP or high PG, and 24 of these received pharmacological treatment. Two of these 39 referred patients suffered from both high BP and high PG. The frequency of pharmacological treatment for high BP at the two data collection sessions is presented in Table 13. At follow-up, there was a significant change in pharmacological treatment; 32 had changed their pharmacological treatment with antihypertensive drugs, of which 28 had started and four had ceased ( $p < 0.001$  McNemar Test).

**Table 13.** Pharmacological treatment for hypertension in 2004 and 2011, according to gender and age

		Total N=170					
Pharmacological treatment for hypertension		Medicating	Not/quit medicating	Missing	Not referred 2004	Referred at risk 2004	Pharmacological treatment 2004
<b>2004</b>	Number of patients	59	111	0	139	31	20
	Mean age (years)	69.5	61.0	0	64.6	61.1	62.0
	Of which male (%)	43.4	45.9	0	39.6	67.7	55.0
<b>2011</b>	Number of patients	76	75	19			
	Mean age* (years)	72.4	65.7	72.0			
	Of which male (%)	40.8	44.0	63.2			
	Number of patients with changed treatment during the 7-year period	28	4				
	Mean age* (years)	69.8	79.0				
	Of which male (%)	46.4	25.0				
	Number of patients with new treatment during the 7-year period				19	9	
	Mean age* (years)				72.0	65.2	
	Of which male (%)				31.6	77.8	

\*Alive

### *Risk*

The future risk for treatment with antihypertensive drugs after seven years, estimated based on the diastolic and systolic BP registered at the initial screening, resulted in the following calculations of OR. The OR for medicating with antihypertensive drugs in 2011, for those not receiving pharmacological treatment at the initial screening in 2004, was 3.7 times greater for patients referred to have their screening values checked on the basis of diastolic BP than for those who not were referred (p=0.025; CI 1.2-11.3).

Based on systolic BP, the OR for medicating with antihypertensive drugs in 2011, for those not receiving pharmacological treatment at the initial screening in 2004, was 3.9 times greater if they had a systolic BP of 140-159 mm Hg at the screening than for those who had a systolic BP <140 mm Hg (p=0.020; CI 1.2-12.6).

The OR for medicating with antihypertensive drugs in 2011, for those not receiving pharmacological treatment at the initial screening in 2004, was 54.2 times greater if they had a systolic BP >160 mm Hg at the screening than for those who had a systolic BP <140 mm Hg ( $p < 0.0001$ ; CI 9.8-300.3).

#### *Correlations among subgroups*

Among the referred group ( $n=31$ ), nine out of those eleven (Table 1) who had not received pharmacological treatment in 2004 had started pharmacological treatment with antihypertensive drugs by the time of the follow-up ( $p=0.004$  McNemar Test).

Among the group of six who had a systolic BP >180 mm Hg and had not received antihypertensive drugs at the initial screening in 2004, one had passed away after seven years, one dropped out and the remaining four medicated with antihypertensive drugs.

Among those who had a systolic BP of 140-159 mm Hg at initial screening, ten had changed their pharmacological treatment with antihypertensive drugs, nine had started and one had ceased ( $p=0.021$  McNemar Test). For those who had a systolic BP of 160-179 mm Hg, nine had started using antihypertensive drugs ( $p=0.004$  McNemar Test). Four who not medicated with antihypertensive drugs and had a systolic BP >180 mm Hg at initial screening medicated after seven years.

### **Diabetes**

#### *Diagnosis and treatment*

Ten of the 39 referred patients exhibited PG values beyond the cut-off level and four of them required further care according to the medical physician.<sup>22</sup> Two suffered from both high BP and high PG. The frequency of pharmacological treatment for DM at the two data collection sessions is presented in Table 14.

**Table 14.** Pharmacological treatment for diabetes mellitus in 2004 and 2011, according to gender and age

		Total N=170					
Pharmacological treatment for diabetes mellitus		Medicating	Not/quit medicating	Missing	Not referred 2004	Referred at risk 2004	Pharmacological treatment 2004
<b>2004</b>	Number of patients	12	158	0	160	10	4
	Mean age (years)	66.8	63.7	0	63.5	70.5	74.8
	Of which male (%)	75.0	42.4	0	43.8	60.0	50.0
<b>2011</b>	Number of patients	16	134	20			
	Mean age* (years)	72.9	68.6	71.2			
	Of which male (%)	56.2	39.6	60.0			
	Number of patients with changed treatment during the 7-year period	3	1				
	Mean age* (years)	70.0	78				
	Of which male (%)	0	0				
	Number of patients with new treatment during the 7-year period				3	0	
	Mean age* (years)				70.0	0	
	Of which male (%)				0	0	

\*Alive

### *Risk*

It was not possible to do risk calculations due to the limited group sizes.

### *Correlations among subgroups*

Regarding pharmacological treatment for DM, three had started and one stopped. The changes in treatment were not significant (p=0.63 McNemar Test).

Further analysis of the data did not show any significance.

### **Incidental finding – BMI**

An incidental finding was the not statistically significant developments of BMI. The original population and the diastolic-based referred group with subgroups had a mean increase of 0.15-0.60 in BMI. Those who had a systolic BP of 140-159 mm Hg at the initial screening had a mean decrease in BMI of -0.24 (CI -0.87-0.39). Those who had a systolic BP of 160-179 mm Hg had a mean increase in BMI of 0.25 (CI -0.39-0.89). However, those who had a systolic BP >180 mm Hg had a mean increase of BMI of 2.05 (CI -2.49-6.59), which is eight times greater average increase in BMI than those with a systolic BP of 160-179 mm Hg at the initial screening.

## 8 DISCUSSION

### 8.1 IDENTIFYING PATIENTS AT RISK IN DENTAL SETTINGS

#### Main findings

We often found undiagnosed high BP and high plasma glucose values in our 170 subjects. Forty patients with high values were referred, with 23 of them requiring further care (13.5% of all participants). The correlation between oral health care and medical care in recording blood pressure was 64.5%, whereas the same correlation for plasma glucose was 60.0%.

No significant correlations between plasma glucose and periodontal status were found. Among elderly subjects, there was a significant correlation between marginal alveolar bone loss and high systolic BP.

High BP, a global problem, was noted in 26.4% of the adult population in 2000 (77), with ischaemic heart disease and cerebrovascular disease being the leading causes of death (78). In this study, we found that registered BP was correlated to radiographic marginal alveolar bone loss. Male subjects 40-65 years of age evidenced the strongest such correlation, as did subjects of both genders aged 65 and over.

#### Incidental findings

Periodontitis in the elderly is not easily confirmed as affected teeth may already have been extracted, because of a perceived need for removal or the previous more technical approach towards dentistry (79). In this study, we noticed incidentally that radiographic marginal alveolar bone loss was present more often than clinical periodontal status, such as BOP linked to pocket depth of  $\geq 4$  mm, probably thanks to the individualized prophylactic care programs used in the clinic concerned. A pocket depth of  $\geq 4$  mm may be a sign of active periodontal disease, while radiographic bone loss is a clear sign of previous periodontal disease.

In the present study, we also incidentally observed that the number of surfaces on which it was impossible to measure marginal alveolar bone loss on x-rays was larger among the oldest patient group. Elderly tend to have a lot of dental restorations that complicate the measurement on bitewing x-rays owing to obscured CEJ (80).

Contemporary Swedish elderly tend to increasingly keep their natural teeth (81). The importance of medical screening for oral health was highlighted in a study in which the authors concluded that the metabolic syndrome and presence of markers for inflammation, in addition to traditional risk factors for tooth loss, represented threats to maintaining natural teeth in elderly populations (82). Relevant current data also support the existence of a relationship between metabolic disturbances and periodontitis (83).

## **Strengths and limitations**

The strength of this investigation is that it was conducted at an ordinary public general dental practice by standard oral health professionals whose mission was to identify patients at risk of CVD and DM. Today, several wrist devices have been validated using the British Hypertension Society protocol; however, validated upper arm devices are still preferred over wrist devices and should, therefore, be recommended for screening activities and control measurements (84). A digital automatic sphygmomanometer generates values algorithmically based on a single registration. Physiologically, the mean ambulatory monitored BP value is more realistic and has better prognostic value in making diagnostic assessments, but is less suitable in a screening situation (85). The results also show that although an ordinary glucometer made for monitoring concentrations of blood glucose at home was used, a correlation with medical health care of 60.0 % was achieved. A limitation of our study is that it was performed in one dental setting alone; other similar clinical research needs to be performed before the results may be considered transferable to all dental environments.

Another limitation is that we made the assumption that patients would feel calm enough to achieve a relevant digital BP registration after a five-minute break. This was not the case, as 88 of 170 patients (51.8 %) patients showed systolic BP above the cut-off value of 140 mm Hg. These results were probably attributable to “white coat hypertension”. Studies have shown that patients with high BP readings at a first appointment with a new physician show a mean fall of 15/7 mm Hg in systolic BP and diastolic BP by their third appointment. Some patients do not reach stable BP values until their sixth appointment (86, 87). Dental fear and phobia tend to complicate medical screening in dental settings, but the benefits of medical screening linked to the dental health system, with its annual recall program, may compensate for these disadvantages.

## **Implications of this study**

Our findings indicate the possibility of identifying risk patients among men and elderly by examining radiographic marginal alveolar bone loss with the help of routine x-rays and by performing medical screenings by measuring BP. However, this requires the establishment of good routines for both the screening procedures and x-ray activities in dental settings. Another issue is whether dental professionals should be involved in the follow-up treatment of hypertension, or alternatively, merely collaborate closely with primary care services in identifying patients at risk.

The absence of a significant correlation between plasma glucose and periodontal status in this study may be attributable to the limited population sample screened or the extended targeted periodontal prophylaxis received by patients with diabetes.



Syrjänen discovered that severe chronic dental infection in young and middle-aged men seems to be strongly associated with stroke (cerebral infarction), a finding that stresses the importance of giving men who evidence markers of periodontal disease extended periodontal prophylaxis (88). According to our study findings, this also seems relevant for elderly patients in the same situation.

In the absence of a definitive causality, our level of knowledge does not yet enable us to call periodontal status a predictive factor for cardiovascular disease or diabetes mellitus. A statistical limitation also occurs when many statistical associations tested are omitted. In such instances, error rates may soar dramatically, thereby increasing the risk of reaching erroneous conclusions. However, the data of our study might be used to propose a description of cardiovascular parameters and plasma glucose concentrations in groups with affected periodontal status. Our findings suggest a need for additional studies with larger population samples.

Among Swedes aged 50 and above, 81.6% of this population reported having seen a dentist within the preceding year in 2007 (89). The continuity of providing ongoing dental services presents an opportunity to identify both oral and general risk factors and points out the benefit of medical screening in dental settings which is why such screening activity has recently been introduced to dentistry and is the subject of research because of its positive results (37, 59, 90-98).

## **8.2 PATIENT EXPERIENCES OF MEDICAL SCREENING PERFORMED BY THE DENTAL SERVICES**

In the present study, it was revealed that all interviewees had a generally positive attitude to undergoing medical screening as part of their regular dental examinations. Dentists' attitudes to medical screening as a part of the dental examination have also been reported to be positive (94, 99).

### **Method discussion**

It is important to achieve trustworthiness in a qualitative study (73). Both authors, Göran Friman and Inger Wårdh, have completed education in qualitative methodology and Inger Wårdh has experience from conducting several qualitative studies. To assure credibility, the interviewer in the present study was a person unknown to the participants and the interviews were conducted in a neutral venue not adjacent to the dental clinic (73).

There was a strategic selection of participants and the sampling continued until the authors concluded that no new information emerged, although there were very few negative comments from the interviewees. The dental clinic at which the screening was carried out

has individualized prophylactic care programs, and some interviewees may have been informed in that context about possible relationships between oral health and general health. All interviewees had previously agreed to undergo medical screening. These factors and the fact that some of the interviewees were referred to the health care services after the medical screening, where they were given further treatment and/or lifestyle recommendations, may have helped them to understand the benefits of the process of medical screening. It is possible that some of the individuals who declined to participate might have had a negative attitude about medical screening. Another choice of method, for example an anonymous postal questionnaire to all those who participated in the screening, might have been more effective at capturing negative attitudes (98).

The researchers made their analyses as quickly as possible after the data collection to minimize the risk of changes in the researchers' interpretations, to increase the dependability (73). After each interview, the interview process was evaluated to secure relevant data for the next interview.

Accurate written description of the research process and the context was made to pursue transferability (73) and to give the reader the ability to evaluate whether these findings are transferable to other contexts.

### **Result discussion**

All but one of the interviewees in this study was positive to the procedure with medical screening in dental settings and were willing to pay for this service. They appreciated the continuity the dental services provide and expressed some dissatisfaction with the absence of such continuity in Swedish health care. Similar positive results are revealed in qualitative studies of patients' attitudes toward diabetes or HIV testing in dental settings (99, 100). A questionnaire study among adults with diabetes in Great Britain revealed that 53.5% of the participants supported dentists' involvement in diabetes screening and that 20.9% would be willing to pay for diabetes screening in a dental setting (101). In the opinion of the authors, this relatively low interest in medical screening in Great Britain may be attributable to poor awareness of the importance of oral self-care and limited awareness of the oral health complications associated with diabetes.

Our interviewees can be regarded as quite well informed about both oral and general health. They had formulated demands and expectations if medical screening were to be introduced in dental care and thought it was self-evident that a dentist has a responsibility to have adequate medical knowledge before undertaking such testing. Dentists have requested training and information about practical procedures if medical screening is introduced (94). Well-established cooperation with the health care services is equally important for optimal management of patients after screening.

It was especially pointed out by several of the interviewees as a major advantage that the dental service provides this contact in the form of a written referral in case of exceeded threshold values. This is the responsibility of the dental service, but dentists are not qualified to make medical diagnoses. The aim of medical screening performed by the dental care service is to identify patients at risk.

As pointed out by the interviewees, this kind of screening could result in false positive results concerning high blood pressure because of “white coat syndrome” in a somewhat intimidating dental environment. This could lead to both unnecessary appointments, overloading the health care system, and unnecessary anxiety in some patients about their health status. However, studies from the US indicate that high blood pressure at the dentist’s office may have other, more relevant, causes and that such patients would benefit from further investigation (102).

The interviewees pointed out the importance of feedback and knowledge of the results of the medical screening. Even those interviewees whose results did not exceed the threshold values for disease risk wanted to receive both oral and written information about their screening results.

Medical screening in dental settings may help individuals with unknown high blood pressure and/or high plasma glucose levels to receive early medical help. This could also be seen in a broader perspective of public health, although the present results are only applicable in their own and possibly similar contexts.

### **8.3 MEDICAL SCREENING IN DENTAL SETTINGS, VIEWS OF AUTHORITIES AND ORGANIZATIONS**

This study showed that the spokespersons were generally positive to medical screening in dental settings but requested more knowledge as they were uncertain about the concept.

#### **Method discussion**

The quantitative questionnaire data were analyzed descriptively by means of respondents’ positive and negative attitudes towards medical screening. The aim was to make the respondents take a position on medical screening. A limitation appeared at this stage, as several respondents avoided answering. But this weakness was turned into a strength in the subsequent collection of qualitative data during the interviews, where respondents were asked why they previously avoided taking a stand, which resulted in a more comprehensive answer. However, this study should not be considered a report from Swedish authorities and organizations concerning medical screening, as some presumptive respondents did not wish to participate.

Achieving credibility is always important in all research, especially qualitative methods (73). To ensure credibility, the interviewer was a person unknown to the respondents and who had limited pre-understanding of the subject (73). The respondents decided themselves where the interview should be conducted. Concerning the telephone interview alternative, there is a lack of additional information due to nonverbal reactions, but this was in some cases the only possibility of holding an interview, and a comparison of face-to-face and telephone interviews has revealed no significant differences in yielded results (103).

A limitation of the study was that the participants responded as representatives of Swedish authorities and organizations but partly with personal opinions. As a spokesperson for an authority or organization, it can be presumed that the spokesperson provides substantially representative answers, as official policy documents are not available. Neither should this study be taken for a total representative report from Sweden.

The transcriptions and analyses were made as quickly as possible after the qualitative data collection to optimize the interpretations and to secure relevant data in order to increase the dependability (73). Accurate written descriptions of the research process and the context were prepared in order to pursue transferability and to give the reader the ability to evaluate whether these findings are transferable to other similar Swedish or foreign contexts (73). When analyzing the collected data, a triangulation could be done to increase the reliability of the results through parallel analysis of the collected quantitative and qualitative data (104).

## **Results discussion**

Medical screenings in dental settings are showing an increasing trend, and in a study involving 28 dental practices in the US and Sweden, the Dental Practice-Based Research Network found that a significant proportion of tested dental patients had abnormal blood glucose values (105). These results confirm the clinical relevance and specific challenge of investigating and describing the view of authorities and organizations in a Swedish context. To our knowledge no studies have been performed concerning this topic.

General health checks are evaluated in the Cochrane review article by Krogsbøll et al (46), who aimed to quantify the benefits and harms of general health checks. The authors summarized with the words “general health checks in adults did not reduce morbidity or mortality”. This review article has been discussed in scientific literature and one weakness of the report is that most studies began in the 1960s and ‘70s. Diagnosis and treatment methods may have changed over time and the report excluded studies involving only elderly individuals over 65 years of age (106). All the reviewed studies also evaluated asymptomatic populations that were excluded for disease or risk factors. The authors suggested finally that future research should focus on, for example, screening for

cardiovascular risk factors, chronic obstructive pulmonary disease, diabetes, or kidney disease, which opens the door for major studies (46).

By the early 2000s, it was already the trend in the US to make dental hygienists an integral part of the health care workforce (56). As prevention specialists, part of their job was considered to be detecting the presence of general diseases. But there were educational requirements for medical screening and they did not make medical diagnoses.

The Swedish National Board of Health and Welfare in Sweden has emphasized the importance of primary preventive measures like medical screening (National Guidelines for Diabetes Care – summary, 2013, <http://www.socialstyrelsen.se/nationalguidelines>). “Health and medical care should carry out a screening of individuals who run an increased risk of developing diabetes type II, primarily in order to offer lifestyle changes.” These guidelines were not directed at dental care at this stage.

The aim of medical screening performed by the dental care service is early identification of patients at increased risk of developing coronary heart disease and diabetes mellitus, yet unaware of their increased risk (107). The same authors also presented that dental settings could be a health promotion entry point into medical care for individuals not previously engaged with a primary care provider (107). The cooperation between dental and medical care has proven to be an effective way to discover unknown hypertension (38, 95).

In their 2015 National Guidelines for Diabetes Care, the Swedish National Board of Health and Welfare recommended that health care refer to dental care individuals with diabetes with increased risk of impaired oral health or ongoing inflammatory disease of the tissues surrounding the teeth and dental implants. This cross-border communication is intended to result in decisions on treatment and preventive measures against caries, periodontitis and peri-implantitis. This guideline promotes an increased cooperation between dentistry and health care (108).

During the interviews it emerged that medical screening could be performed in many contexts, but experience indicates that routine opportunistic screening is easier to implement and more reliable than other screening programs that cannot leverage the existing infrastructures and human resources of formal medical settings (109). Dental settings are therefore a natural choice of context alongside primary medical care.

Dentistry today is increasing cooperation with medical care regarding the treatment of other diseases that might be associated with hypertension, such as obstructive sleep apnea syndrome, OSAS (110, 111). This further points to dentistry as a preferable context for medical screening.

Some of the respondents felt that an early diagnosis is always economically beneficial for society, but they had little knowledge of what savings could be achieved. The cost effectiveness of screening is important, and this effectiveness was studied in a Swedish population and found to depend on whether blood pressure screening was combined with blood glucose screening as compared to separate screening for the two disease entities (112).

An estimation made in United States indicated that medical screenings for diabetes mellitus, hypertension, and hypercholesterolemia in dental settings could save the health care system \$13.51-\$32.72 per person screened over one year, depending on the referral flow from dental care to health care (113). The reported estimated socio-economic benefits in the article have been supported by others (114).

Nearly all spokespersons for the authorities or organizations replied that they had a lack of knowledge on the topic but saw opportunities for individual and societal gains with medical screening in dental settings.

This study shows that the expected impact and implications for clinicians and policy makers is to further enhance the implementation and intensify research on medical screening in dental settings.

#### **8.4 LONG-TERM FOLLOW-UP OF OPPORTUNISTIC MEDICAL SCREENING WITHIN DENTISTRY**

In this study, we found the distribution of risk, diagnosis and treatments for HT and DM after seven years among patients screened in a dental setting, to be considerable and not easily predictable among subgroups.

##### **Strengths and limitations**

The strengths of this study were that it was conducted at an ordinary general dental practice and that it was possible to conduct a seven-year follow-up with few dropouts, which in turn made it feasible to evaluate potential long-term effects of the medical screening. However, the study also has limitations. First, the registration of pharmacological treatments at the initial screening and in the present follow-up study was based on self-reported information, which can cause internal bias. Second, the number of participants was limited and taken from a limited context. There was hardly any tooth loss among the participants during the seven years, probably due to the study clinic's individualized prophylactic treatment program. This could explain why the results revealed no significant associations between periodontitis, tooth loss and pharmacological treatment for high BP or DM, as a number of other studies have found (115, 116).

## **Hypertension**

Hypertension is an age-related, slow-developing and leading risk factor for premature death. The correlation with increased age was showed in the present study as the prevalence of HT treatment increased from 34.7% to 50.3% during the seven-year period. It can be compared with a study conducted in Stockholm, Sweden from 2001 to 2004, where the prevalence for HT was 74.9%, and 41.6% of the total study population medicated (12). In the MONICA study, the prevalence for HT was 71.9% and 44.9% of the total study-population used pharmacological treatment with antihypertensive drugs (13).

## **Diabetes**

During the seven years, there was an increase in the prevalence of treatment of diabetes, from 7.1% in 2004 to 10.7% in 2011. This could be compared to a 2015 estimation of 17-21% for the Swedish population aged 60-69 years, with data taken from IDF Diabetes Atlas Seventh Edition 2015 (7). The present study's lower prevalence may be due to the participants' socioeconomic status or local medical assessments. It is more similar to the previously mentioned Stockholm study, where the participants' mean age was 74.0 years and the prevalence for diabetes was 9.5% (12). The MONICA study of a population aged 65–74 years in Northern Sweden showed a prevalence of 12.0% for diabetes in 2009 (13).

## **Number needed to screen**

At the initial screening, 31 out of the 39 referred participants were referred due to a diastolic BP beyond the cut-off level. Twenty of these required further care according to the examining medical physician. Twenty out of a total of 170 screened participants (11.8%) thus required further care (38). The number needed to screen in this context was 8.5, which is a result that is consistent with another Swedish study that reported a number needed to screen of 12 to detect an individual with undiagnosed high BP (117). The finding that systolic BP increased the odds of receiving pharmacological treatment raises the question about how to select patients for referral to medical care.

## **Implications for medical screening delivery and context**

The finding that some patients had suboptimal BP monitoring from healthcare services has been demonstrated in other studies (12, 13), and leads to the question of whether dental care should be involved as part of a multidisciplinary team to support the follow-up of prescriptions from health care providers (118). Medical screening can be performed in many contexts, not just in dental settings. However, all such activities have to be carried out in cooperation with health care. Such collaboration is supported by a majority of primary care practitioners and is demanded by the patients (119, 120).

Debatable benefits of general health checks are evaluated in a review article from Cochrane, and the authors suggested that future research should focus on screening for cardiovascular risk factors, chronic obstructive pulmonary disease, diabetes, or kidney disease (46). In England, the NHS Health Check programme in adults aged 40–75 was introduced in 2009. The intention was early identification of these non-communicable diseases (48). In order to reach more citizens, partnering dental care with primary care is being considered in order to reach the goal of screening once every five years (121). The results from the present study suggest that patients identified as risk patients may be screened each year, while those in these age groups who at screening are found to be healthy, may be screened every other year. Further research is needed, however, to confirm these proposed screening intervals.

## **8.5 GENERAL DISCUSSION**

In the first study, all participants were tested regardless of whether they already had a diagnosed hypertension and/or DM or not. However, the PG level in diabetes varies and therefore can be an unreliable measurement to take in to consideration (122).

The four articles in this thesis describe how an opportunistic medical screening in a dental setting in 2004 identified one out of seven patients to be in need of medical care, and that the patients were positive to the screening. The authorities and organizations approached in the studies were generally positive, however their representatives were uncertain about the concept. The fourth follow-up study revealed that opportunistic medical screening in a dental setting can be positive for public health both in the short- and in the long-term and supported more integrated healthcare practices between dental care and healthcare.



## **9 SUMMARY AND CONCLUSIONS**

### **SUMMARY**

An opportunistic medical screening seems to identify at least one in ten with undiagnosed hypertension or incorrect pharmacological treatment, and risk patients referred by dentistry who are not considered to require further healthcare interventions may benefit from an annual screening. The results also emphasize the need for an increased cooperation between dentistry and health care.

### **CONCLUSIONS**

#### **Study I**

The correlation between oral health care and medical health care registrations based on blood pressure and plasma glucose indicates that it may be appropriate for dental professionals to perform opportunistic medical screening and refer risk patients to the medical care system before complications occur. In order to identify medical risk patients in dental settings on the basis of high blood pressure, a suggestion may be to examine middle-aged men and elderly patients of both sexes who exhibit radiographic markers for marginal alveolar bone loss.

#### **Study II**

The interviewees experienced the dental care service as providing continuity. They would like to have regular medical screening at their regular dental appointments to identify risks of cardiovascular diseases and diabetes. However, they expressed that it was important for the dental care staff to have the necessary medical knowledge.

They also wanted good cooperation between the dental and health care services, with clear feedback to the patients about both positive and negative results and, when appropriate, referrals to the health care service.

#### **Study III**

Approached authorities and organizations generally had a positive view of medical screening in dental settings but were uncertain about the concept. Further scientific knowledge and guidelines concerning the topic are needed before it can be commonly introduced and additional research on implementation strategies and long-term follow-up of medical screening are needed.

## **Study IV**

An opportunistic medical screening in dental settings seems to identify at least one in ten with undiagnosed hypertension or incorrect medication. If a systolic BP >160 mm Hg forms the assessment basis, a larger number could be identified.

This study implicates that risk patients referred by dental care who are not considered to require further healthcare interventions may benefit from an annual dental care screening. Our results also emphasize the need for a more integrated health care practice for opportunistic screening.

## 10 SWEDISH SUMMARY

### Bakgrund

Hjärtkärlsjukdomar och diabetes mellitus typ 2 ökar. Ju tidigare patienten kommer i kontakt med sjukvården, desto större möjlighet till enklare åtgärder såsom livsstilsråd för att minska risken för framtida komplikationer. Vanligen uppsöks sjukvården först vid tydliga symtom. Tandvården tillämpar regelbundna revisioner och har ett förebyggande synsätt. Den kan utgöra en arena för medicinsk screening och identifiera personer i riskzonen för odiagnostiserat högt blodtryck eller diabetes. Sådan verksamhet ligger utanför den rent odontologiska även om aktuell forskning påvisar associationer mellan oral och allmän hälsa. Tandvården ställer dock inte medicinska diagnoser.

Screening anses både vara kostnadseffektivt och kunna ge folkhälsovinster. Men hur ska den utföras på bästa sätt? Samarbetet med sjukvården har poängterats, men det finns inget regelverk att luta sig mot. Ska alla patienter erbjudas medicinsk screening eller endast vissa grupper och hur ska en god återkoppling av screeningresultatet ges?

Det övergripande syftet med avhandlingen var att undersöka möjligheter att hitta individer i riskzonen för odiagnostiserade sjukdomar och till ett samarbete kring detta mellan tandvården och sjukvården.

De inledande målen var att identifiera tandvårdspatienter med risk att ha eller utveckla högt blodtryck eller hög halt plasmaglukos, undersöka möjliga samband mellan dessa tillstånd och munhälsan samt att utforska överensstämmelsen mellan tandvårdens och sjukvårdens registreringar.

Patienternas upplevelser samt myndigheters och organisationers syn studerades i en andra och tredje studie. Efter sju år analyserades hälsoutvecklingen och medicineringen beträffande högt blodtryck och diabetes bland dem som deltog i den initiala medicinska screeningen i en fjärde och sista studie.

### Material och metod

Totalt 170 tandvårdspatienter inkluderades konsekutivt vid en årlig revisionsundersökning. Uppgifter om ålder, vikt, längd, mängd och användning av tobak och läkemedel för hjärtkärlsjukdom och diabetes samlades in med en hälsodeklaration samt data om systoliskt och diastoliskt blodtryck och plasmaglukos. Klinisk och röntgenologisk undersökning gav uppgifter om parodontalt status genom ficksondering och genom att mäta marginal alveolär benförlust med hjälp av röntgen. Patienter som överskred normalvärden för diastoliskt blodtryck och plasmaglukos remitterades till sjukvården för eventuell diagnos och behandling (Studie I).

Med ett strategiskt urval av patienter, myndigheter och organisationer intervjuades 17 patienter och 13 talespersoner. Intervjuerna spelades in och transkriberades. Transkriptionerna kodades och kategoriserades i en manifest analys, följt av en latent, tolkande analys (Studie II & III).

De 170 deltagare som ingick i den inledande screeningen tillfrågades sedan om att delta i en uppföljningsstudie efter sju år. Data samlades in genom en upprepning av hälsodeklarationen (Studie IV).

## **Resultat**

Trettionio av samtliga 170 deltagare uppvisade höga värden vid screeningen och remitterades. Av dessa 39 patienter, var 24 (14,1 %), en av sju screenade, i behov av sjukvårdsinsats. Korrelationen mellan tandvårdens registreringar och sjukvårdens beträffande blodtryck var 64,5 % ( $p < 0,001$ ), medan korrelationen beträffande plasmaglukos var 40,0 % ( $p < 0,001$ ). Bland medelålders män och äldre, fanns en signifikant korrelation mellan marginal alveolär benförlust och högt systoliskt blodtryck ( $p < 0,001$ ) (Studie I).

Den manifesta analysen, det som direkt uttrycktes i transkriptionerna av patienternas upplevelser, resulterade i tre kategorier: Positiv attityd till screening, men tandvården behöver kunskap om medicinsk screening; Tandvården står för kontinuitet, men är inte en neutral miljö; Feedback på den medicinska screeningens resultat och önskan om samarbete mellan tandvården och sjukvården (Studie II).

Den manifesta analysen av talespersonernas syn vid de utsedda myndigheterna och organisationerna, resulterade i fyra kategorier: Medicinsk screening bör etableras i samhället; Tandvården måste ha relevant kompetens för att utföra medicinsk screening; Tandvården är inte den enda kontext där medicinsk screening kan utföras; Medicinsk screening kräver samarbete mellan tandvården och sjukvården (Studie III).

Den latent, tolkande analysen av patienternas upplevelser påvisade krav på att registreringarna genomfördes korrekt och säkert, samt att de önskade tydlig feedback om screeningens resultat. De intervjuade talespersonerna såg positivt på medicinsk screening, men upplevde brist på evidens inom ämnet samt riktlinjer för genomförandet. De var osäkra på konceptet (Studie II & III).

I den uppföljande fjärde studien deltog 151 av de ursprungliga deltagarna. Med det insamlade materialet och data från den första studien analyserades hur stor risken (Odds Ratio) var att 2011 ha utvecklat behov av blodtryckssänkande läkemedel efter sju år, för dem som inte fick det vid den inledande screeningen 2004.

För dem som inte fick läkemedel 2004, var risken 3,7 gånger större för dem som remitterades för att få sina screening-värden kontrollerade på grundval av diastoliskt blodtryck än för dem som inte remitterades ( $p = 0,025$ ; CI 1,2–11,3).

För dem som inte fick läkemedel 2004 och registrerades med ett systoliskt blodtryck 140–159 mm Hg, var risken 3,9 gånger större än för dem med ett systoliskt blodtryck <140 mm Hg ( $p=0,020$ ; CI 1,2–12,6). För dem med ett systoliskt blodtryck >160 mm Hg, var risken 54,2 gånger större att ha utvecklat behov av blodtryckssänkande läkemedel efter sju år, än för dem med ett initialt systoliskt blodtryck <140 mm Hg ( $p<0,0001$ ; CI 9,8–300,3) (Studie IV).

Beträffande läkemedelsbehandlad diabetes, var det inte möjligt att göra riskberäkningar på grund av de begränsade gruppstorlekarna. Förändringarna var inte signifikanta.

### **Konklusion**

Korrelationen mellan tandvårdens och sjukvårdens registreringar indikerar att det kan vara lämpligt att tandvården utför opportunistisk medicinsk screening då det kan gagna folkhälsan. Patienter och talespersoner för myndigheter och organisationer ställer sig i huvudsak positiva till en sådan verksamhet.

En opportunistisk medicinsk screening tycks kunna identifiera en individ med odiagnostiserat högt blodtryck eller med okontrollerad medicinering av tio undersökta. De som remitteras av tandvården, men som av sjukvården inte anses kräva ytterligare hälso-och sjukvårdsinsats, tycks ha nytta av årlig screening. Resultaten betonar också behovet av ett ökat samarbete mellan tandvården och sjukvården.

Ytterligare kunskap krävs innan opportunistisk medicinsk screening inom tandvården mer allmänt kan introduceras, likaså behövs forskning om strategier för implementering och långtidsuppföljande studier för att säkerställa effekterna.

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## 13 ORIGINAL PAPERS