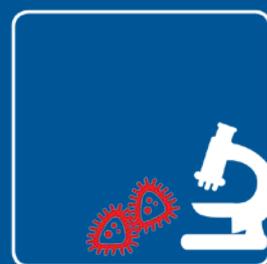


SLUTRAPPORT

NR. 2012-114

# Mælk og oral sundhed



# AFSLUTNINGSRAPPORTEN

## Projekttitle

**Mælk og Oral Sundhed** (Danske mejeriprodukters sundhedsfremmende og forebyggende effekt i relation til oral sundhed generelt og paradontose i særdeleshed)

## Projektleder

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## Projektperiode

Jan 2009 – Jul 2011 (incl. cirka 11 måneders barselsorlov)

## Finansieringskilder

Mejeribrugets ForskningsFond

Bispebjerg Hospital; Region H

## Sammendrag

Dentale sygdomme er almindelige og næsten alle har haft caries, gingivitis eller parodontitis. Disse lidelser kan udvikle sig til tab af tænder, som har en stor indvirkning på det generelle velbefindende. Dentale sygdomme er kroniske tilstande, som det forventes delvist kan forebygges ved indtagelse af en sund kost. Men først for nylig er der begyndt at blive fokuseret på forskning i de ernæringsmæssige determinanter for tandsygdomme. Formålet med dette projekt var at undersøge effekten af indtag af mejeriprodukter på den generelle tandsundhed, herunder parodontose og tab af tænder hos voksne og ældre i Danmark. To undersøgelsespopulationer blev inkluderet i dette projekt, med den fællesnævner at der var oplysninger om kostindtaget samt var blevet foretaget en vurdering af den orale sundhed.

MONICA populationen: Inkluderede 432 voksne danskere (30-60 år), alle med oplysninger om calcium indtag i 1982/83 og tab af tænder fra 1987/88 til 1993/94.

Københavns Oral Health Senior Study (COHSS): Inkluderede 684 personer (ud af 733) i alderen 65+ år med komplette data omkring kostindtag, og derudover en oral undersøgelse for caries og den orale mikrofloraprofil. Desuden 172 personer med parodontalundersøgelse.

MONICA: Blandt mænd, var et højt calciumindtag fra mejeriprodukter signifikant associeret med en reduceret risiko for tandtab (IRR = 0.61; 95% CI = 0.44 – 0.88), selv efter justering for en bred vifte af konfoundere. Blandt kvinder var sammenhængen ikke signifikant i de rå modeller, men efter justering for orale *Lactobacillus* blev sammenhængen også statistisk signifikant for kvinderne (IRR = 0.55; 95% CI = 0.34 – 0.87). Calcium fra andre kilder end mejeriprodukter var ikke forbundet med tab af tænder blandt hverken mænd eller kvinder i de fuldt justerede modeller. COHSS: Hos både mænd og kvinder var lavt indtag af mælk (IRR = 0.96; 95% CI = 0.93 – 0.99) og fermenterede fødevarer (IRR = 0.93; 95% CI = 0.88 – 0.98), forbundet med øget forekomst af parodontose. Indtag af ost og andre mejeriprodukter var ikke forbundet med parodontose. Konklusion: Kosten calcium indhold, og især calcium fra mejeriprodukter, ser ud til at beskytte mod tab af tænder og parodontitis blandt voksne mænd og kvinder.

## Abstract

Dental diseases are common and almost every individual has had an incidence of caries, gingivitis or periodontitis. These conditions can progress to tooth loss, which has a major impact on the wellbeing of individuals. Dental diseases are chronic conditions that may be preventable by healthy diet. However, only recently attention has been given to research on nutritional determinants of dental diseases. The aim of this project is to investigate the effect of dairy products intake on general dental health, such as periodontitis and tooth loss among adults and elderly in Denmark. Two studies were included in this project with the common denominator of dietary assessment and oral examination.

MONICA: 432 Danish adults (30-60 y) with information on calcium intake in 1982/83 and tooth loss from 1987/88 to 1993/94.

The Copenhagen Oral Health Senior Study (COHSS): 684 individuals (out of 733) aged 65+ years with complete data on dietary intake, caries examination and oral microflora profile and 172 individuals with complete data on periodontal examination.

MONICA: Among men, dairy calcium intake was significantly associated with a reduced risk of tooth loss (IRR = 0.61; 95%CI= 0.44 – 0.88) even after adjustment for wide range of confounders. Among women, dairy calcium was not statistically associated with tooth loss in the crude and adjusted models. However, the association became highly significant once *Lactobacillus* count was included in the model (IRR= 0.55; 95%CI= 0.34 – 0.87). Non-dairy calcium was not associated with tooth loss among men and women in the fully adjusted models.

COHSS: In both men and women intakes of milk (IRR = 0.96; 95%CI = 0.93 – 0.99) and fermented foods (IRR = 0.93; 95%CI = 0.88 – 0.98) were inversely associated with periodontal disease. Intakes of cheese and other dairy products were not associated with periodontitis.

Conclusion: Dietary calcium intake, particularly calcium from dairy products, seems to protect against loss of teeth and periodontitis among adult men and women.

# Mælk og Oral Sundhed ”Milk and Oral Health”

## Background

Dental diseases are common and almost every individual has had an incidence of caries, gingivitis or periodontitis. If left untreated, these conditions can progress to tooth loss <sup>1</sup>, which has a major impact on the wellbeing of individuals <sup>2;3</sup>. Fortunately, dental diseases are chronic conditions that may be preventable by healthy diet <sup>4</sup>. However, only recently attention has been given to research on nutritional determinants of dental diseases. Therefore, the role of certain nutrients in the pathogenesis of oral diseases is still unclear.

It is suggested that diet may influence dental health via systemic or local effects. The systemic effects may influence tooth development and growth, or the resistance to development of dental disease. Local effects include those working via influences on oral biofilms, saliva and bacteria of importance for development of dental disease <sup>5;6</sup>.

The main (general) objective of this project was:

- To investigate the effect of dairy products intake on general dental health status, particularly on the occurrence of periodontal disease among adults and elderly in Denmark.

The specific objectives were:

- To investigate the association between calcium intake and tooth count and tooth loss over 5 and 11 years of follow-up. (STUDY I)
- To investigate whether calcium from dairy products has a stronger protective effect on long-term tooth retention compared to dietary calcium from other sources. (STUDY II)
- To investigate the role of lactobacillus counts on the association between calcium intake and tooth loss. (STUDY II)
- To elucidate which types dairy products (e.g. milk, fermented beverages or cheese) have stronger effects on oral health such as, periodontal disease. (STUDY III)
- To investigate the association between calcium intake below recommendation and plaque score. (STUDY IV)

## Methods

Two studies were included in this project with the common denominator of dietary assessment and oral examination:

1. The **MONI**toring Trends and Determinants in **CARD**iovascular Disease study (MONICA): prospective study including 1602 adults (30-60 y) with information on dietary calcium intake and number of teeth either in 1987/88 or 1993/9 and a subset of 432 participants with information on tooth loss from 1987/88 to 1993/94.
2. The **Copenhagen Oral Health Senior Study (COHSS)**: cross-sectional study including 684 individuals (out of 733) aged 65+ years with complete data on dietary intake, caries and plaque examination and oral microflora profile and subset of 172 individuals with complete data on periodontal examination.

In the MONICA study calcium intake was estimated by a 7-day food record or a diet history interview in 1982/83. In the COHSS calcium intake was estimated by diet history interview.

## **Results**

We used data from MONICA in the STUDY I & II and data from COHSS in the STUDY III & IV.

### **STUDY I**

Dietary calcium intake below recommendations was more frequent among women than men (55% vs. 45%;  $p < 0.001$ ). Low calcium intake was associated with low number of teeth (1–25 vs. 26–32 teeth) in men [odds ratio (OR) = 1.57 (95% CI = 1.10–2.29)] and women [OR = 1.44 (95% CI = 1.10–2.05)] after adjustment for age, education, smoking, alcohol and sucrose consumption, subjective oral dryness, and time since last dental care visit. The reference group (26–32 teeth) and edentulous (no tooth) participants did not significantly differ.

After adjustment for confounders, men who reported calcium intake below recommendations had greater risk [OR = 2.70 (95%CI = 1.37-5.19)] of losing at least 10% of their teeth during follow-up. There was no association in women ( $P = 0.780$ ). When using calcium intake as a continuous variable and tooth loss as a counting variable, we found that for every 10% increase in calcium intake the IRR (incidence rate-ratio) of tooth loss in males was reduced by 55%. There was no association in women.

### **STUDY II**

The present study is an offshoot of the MONICA cohort study (STUDY I), which consists of refined analyses of our previous findings on the gender differences in the relationship between total dietary calcium intake and tooth loss.

Total calcium intake was divided into dairy and non-dairy sources. Dairy foods contributed an average of 58.7% and 62.6% of the total dietary calcium intake among men and women, respectively. Among men, a unit increase in dairy calcium intake was significantly associated with a

reduced risk of tooth loss (IRR = 0.61; 95%CI= 0.44 – 0.88) even after adjustment for tooth count in 1987/88, age, education, civil status (model 1), smoking, alcohol, sucrose and vitamin and/or mineral supplement intake (model 2), time since last dental visit, presence of oral dryness (model 3) and high *Lactobacillus* count (model 4). Among women, dairy calcium was not statistically associated with tooth loss in the crude and adjusted models (from model 1 to model 3). However, the association became highly significant once *Lactobacillus* count was included in model 4 (IRR= 0.55; 95%CI= 0.34 – 0.87). Therefore, it seems that the gender differences found in the relation between calcium intake and tooth loss in STUDY I may be the result of differences in caries risk between genders.

Non-dairy calcium was not associated with tooth loss among men and women in the fully adjusted models.

### STUDY III

The mean intake of dairy foods was 334.3 g/day (range: 34 – 2247g). Milk was the major source of dairy consumption (185.2 g ± 256.3 ) followed by fermented foods (98.3 g ± 138.8), cheese (35.7 g ± 39.6) and other types dairy food (15.1 g ± 23.6).

Intakes of total dairy calcium (mg) and calcium exclusively from milk were inversely and significantly associated with risk of periodontal disease in both adjusted and crude models. Intake of calcium from fermented foods was not significantly associated with periodontal disease in the crude model (IRR = 0.99; p = 0.667), but the association became significant after adjustment for confounders (IRR = 0.95; p = 0.014). Intakes of calcium from cheese and calcium from non-dairy sources were not significantly associated with periodontal disease regardless of adjustment for confounders (Table 1).

**Table 1.** The association (IRR) between dairy and non-dairy calcium intakes and number of teeth with periodontal disease

	Dairy calcium (mg/d)				Non-dairy calcium (mg/d)			
	Crude		Adjusted <sup>†</sup>		Crude		Adjusted <sup>†</sup>	
	IRR* (95% CI)	P	IRR* (95% CI)	P	IRR* (95% CI)	P	IRR* (95% CI)	P
Total	0.97 (0.95 – 0.99)	0.008	0.97 (0.95 – 0.99)	0.003	0.98 (0.96 – 1.00)	0.097	0.98 (0.96 – 1.02)	0.279
Milk	0.96 (0.93 – 0.98)	0.001	0.97 (0.94 – 0.99)	0.020				
Cheese	0.99 (0.97 – 1.02)	0.892	0.99 (0.96 – 1.03)	0.614				
Fermented foods	0.99 (0.95 – 1.03)	0.667	0.95 (0.91 – 0.99)	0.014				

<sup>†</sup> Model adjusted for age, gender, education, sucrose intake, alcohol consumption, smoking, physical activity, vitamin D intake, visit to the dentist, use of dental floss, bleeding and plaque.

\*Incidence-rate ratio (IRR) is for each 100 mg increase in calcium intake

The associations for dairy foods intake followed the same pattern of calcium intake. Intakes of all types of dairy foods and milk were inversely and significantly associated with risk of periodontal

disease in both adjusted and crude models. Intake of fermented foods was not significantly associated with periodontal disease in the crude model (IRR = 0.99;  $p = 0.720$ ), but the association became significant after adjustment for confounders (IRR = 0.93;  $p = 0.011$ ). Cheese intake was not significantly associated with periodontal disease in both crude and adjusted models (Table 2).

**Table 2.** The association (IRR) between intake of dairy foods and number of teeth with periodontal disease

	Dairy calcium (g/d)			
	Crude		Adjusted <sup>†</sup>	
	IRR* (95% CI)	P	IRR* (95% CI)	P
Total	0.96 (0.93 – 0.98)	0.002	0.95 (0.92 – 0.98)	0.001
Milk	0.95 (0.93 – 0.99)	0.001	0.96 (0.93 – 0.99)	0.023
Cheese	0.98 (0.97 – 1.02)	0.821	0.94 (0.77 – 1.15)	0.554
Fermented foods	0.99 (0.94 – 1.04)	0.720	0.93 (0.88 – 0.98)	0.011

<sup>†</sup> Model adjusted for age, gender, education, sucrose intake, alcohol consumption, smoking, physical activity, vitamin D intake, visit to the dentist, use of dental floss, bleeding and plaque.

\*Incidence-rate ratio (IRR) is for each 100 g increase in intake of dairy foods.

## STUDY IV

Plaque score was classified as above vs. below the median value (9.5%) and total dietary calcium intake was classified as within vs. below the recommendations (adults  $\geq 50$  y need 1200 mg calcium/d). All analyses were stratified by vitamin D intake above vs. below the median value (7  $\mu\text{g/d}$ ).

Among individuals with higher intake of vitamin D, dietary calcium intake within recommendations was associated with lower plaque score (OR = 0.5; 95% CI 0.29 – 0.86) after adjustment for age, gender, education, number of remaining teeth, alcohol consumption, smoking, sucrose intake, use of dental floss, visit to the dentist and low salivary rate. Among individual with lower intake of vitamin D, dietary calcium intake within recommendations was not significantly associated with plaque score (OR = 0.9; 95% CI 0.55 – 1.73).

## Conclusions

Given the high percentage of Danish adults with calcium intake below recommendations presented in STUDY I, consumption of foods rich in calcium (e.g. dairy products) should be promoted to preserve oral health. For the STUDY II we conclude that dietary calcium intake, particularly calcium from dairy products, seems to protect against loss of teeth among adult men and women. The previous gender differences found in the relation between calcium intake and tooth loss may be the result of differences in caries risk between genders. In both STUDIES I and II, non-dairy calcium was not associated with tooth loss. The role of low intake of dietary calcium in the initiation and progression of tooth and oral bone loss should be confirmed in further studies, preferably including full dentate individuals followed for a long period and with information on additional risk factors for tooth loss measured throughout the study.

In the study III, our findings showed that intakes of dairy foods in particular milk and fermented products were significantly associated with a reduced risk of periodontal disease. The magnitude of the association between milk and fermented foods did not significantly differ. We did not find evidence of the additional benefit of fermented foods provided by probiotic bacteria on oral health compared to other dairy products (e.g. milk). In addition we did not find association between intakes of non-dairy calcium, and cheese and periodontal disease.

The absorption of dietary calcium is a critical factor in determining the availability of calcium for alveolar bone mineralization<sup>7</sup>. Both exogenous and endogenous factors influence calcium bioavailability. Level of calcium intake, vitamin D status, phytates, oxalates, lipids, phosphopeptides and other proteins, lactose, phosphorus and caffeine are among the exogenous factors influencing the intestinal calcium absorption<sup>8</sup>. In STUDY IV, we found that the protective effect of calcium intake within recommendations was observed only among individuals with higher vitamin D intake.

Most dairy products are a good source of calcium although the total amount of calcium (mg/ 100g) may vary according to each type of product<sup>9</sup>. The nutrients and components present in dairy products may also vary. When specific nutrients and their food sources are both associated with a health condition, the associations are less likely to be spurious. Although dietary guidelines are given in term of nutrients, people do not consume nutrients but foods. Therefore, nutritional advice for health promotion and disease prevention should be based on food or food patterns rather than single nutrients.

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## Publikationer og offentliggørelser

### Artikler i internationale tidsskrifter

1. Adegboye AR, Christensen LB, Holm-Pedersen P, Boucher BJ, Heitmann BL. Intake of Dairy Products in relation to Periodontitis in Danish Elderly (to be *submitted shortly*)
2. Adegboye AR, Christensen LB, Holm-Pedersen P, Boucher BJ, Heitmann BL. Calcium intake and plaque score in Danish Elderly (Short communication: *to be submitted to Nutrition*)
3. Adegboye AR, Twetman S, Christensen LB, Heitmann BL. Intake of dairy calcium and tooth loss among adult Danish men and women. *Nutrition*. Epub . Available online 27 March 2012
4. Adegboye AR, Fiehn NE, Twetman S, Christensen LB, Heitmann BL. Low calcium intake is related to increased risk of tooth loss in men. *J Nutr*. 140(10):1864-8. Epub 2010 Aug 25
5. Adegboye AR, Fiehn NE, Twetman S, Christensen LB, Heitmann BL. Lav calciumindtagelse er relateret til forøget risiko for tandtab. *Tandlægebladet* 2010 nr. 12; 955 (extended *Danish abstract*)

### Populærvidenskabelige artikler

1. Adegboye AR, Seeger C, Heitmann BL. Oral effect: har mejeriprodukter en forebyggende effekt på den orale sundhed? *Mælkritidende* 2010 nr 17; 10-11 (*Study protocol*)
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### Indlæg ved faglige kongresser, symposier, etc.

1. Adegboye AR, Twetman S, Christensen LB, Heitmann BL. Dairy calcium intake and tooth loss among Danish adults. *Oral presentation at 11<sup>th</sup> European Nutrition Conference in Madrid 2011*
2. Adegboye AR, Twetman S, Christensen LB, Heitmann BL. Calcium, milk and teeth in the elderly. *Diætistmøder* Sep 2011

### Mødeindlæg

Amanda R A Adegboye:

Milk and oral health. MFF -styregruppemøde Sundhed og ernæring. 2009, 2010 & 2011

Mælk og oral sundhed. Mejeriforskningens Dag 2011 (*presented by Berit L. Heitmann*)

Calcium intake and tooth loss: a long-term follow-up. Staff meeting, Institut for Sygdomsforebyggelse. Sep 2009

# **Forskeruddannelse**

## **Forskeruddannelse**

Postdoctoral program of Amanda R Amorim Adegboye

## **Tilknyttede gæsteforskere**

None

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## **Praktisk og videnskabelig betydning for mejeribruget**

In this project, we found that an increased intake of dairy calcium was associated with a reduced risk of tooth loss in both men and women and that calcium from non-dairy sources had appreciably no effect on tooth loss. The results therefore suggest that dairy foods might be the best source of calcium for adults and potentially for all age groups.

The health benefits of milk can be achieved from milk directly or its products. We found that not only calcium component of dairy foods was associated with oral health, but also the absolute (g/d) consumption of dairy foods was associated with oral health. This indicates that other components of dairy foods (casein, whey, vitamins, bifidobacterium, etc) might play a role in the prevention of oral health problems. Intakes of both milk and fermented products were significantly associated with a reduced risk of periodontal disease. However, the magnitude of the association between milk and fermented foods did not significantly differ. The study did not find association between intake of cheese and periodontal disease. However, we cannot exclude the possibility that the lack of association might be due to lack statistical power induced by the relatively low range of cheese intake compared to milk and fermented foods. Although our findings have strengthened the scientific evidence of the health benefits of dairy products on oral health it worthy to highlight that we used cross-sectional data. Therefore, our promising results need to be confirmed in other well-designed prospective studies in order to infer causality.

## **Relation til andre/nye mejerirelaterede samarbejdsprojekter**

The present project adds to the other beneficial effects on health of total as well as dairy calcium such as those found in relation to obesity and metabolic problems. In addition, our findings will be used to guide future research (further analysis on caries development) we intend to conduct related to the application we have submitted, if granted.