Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

Impaired glucose metabolism is associated with tooth loss in middle-aged adults: The Northern Finland Birth Cohort Study 1966

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ARTICLE INFO

Article history:
Received 9 March 2018
Accepted 22 May 2018
Available online 30 May 2018

Keywords:
Prediabetes
Impaired fasting glucose
Impaired glucose tolerance
Tooth loss
Adult

ABSTRACT

Aim: We investigated the association of impaired glucose metabolism with tooth loss in adults in the Northern Finland Birth Cohort Study 1966 (NFBC1966).

Methods: We examined 4394 participants from the 46-year follow-up of the NFBC1966. Self-reported number of teeth as well as insulin and glucose values, taken during a standard oral glucose tolerance test (OGTT), served as the primary study variables. A multinomial logistic regression model served to analyse (unadjusted, smoking-adjusted and fully adjusted) the association between number of teeth (0–24, 25–27, 28–32) and glucose metabolism in women and men.

Results: Among women, type 2 diabetes – whether previously known or detected during screening – pointed to a higher likelihood of 0–24 teeth (fully adjusted OR = 2.99, 95%CI = 1.54–5.80) and 25–27 teeth (OR = 1.91, 95%CI = 1.18–3.08) than did normal glucose tolerance. Similarly, impaired fasting glucose and impaired glucose tolerance together indicated a higher likelihood of 0–24 teeth (OR = 1.71, 95%CI = 1.09–2.69) than did normal glucose tolerance. A similar, statistically non-significant, pattern emerged among men. Number of teeth associated with OGTT insulin and glucose curves as well as with the Matsuda index in both women and men.

Conclusions: Tooth loss strongly associated with impaired glucose metabolism in middle-aged Finnish women.

1. Introduction

Tooth loss can substantially impair one's quality of life, causing limited chewing ability, poor dietary intake and functional disorders [1]. Research has shown diabetes and cardiovascular diseases to associate with oral health and tooth loss [2–5], and elevated glucose levels with common periodontal disease [6–8]. Similar finding has been reported

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https://doi.org/10.1016/j.diabres.2018.05.035
0168-8227/

between glucose concentration and the number of teeth [8].

Prediabetes is a non-disease condition characterised by elevated fasting or postprandial blood glucose levels. Concurrently, people with diabetes are often obese and suffer from hypertension [9]. Failure to halt the process will lead to prediabetes eventually progressing to diabetes mellitus. Recognising a prediabetic state early on is therefore essential to initiate individual lifestyle changes, focusing on weight control, physical exercise and dietary intake, to postpone or prevent a diabetes diagnosis [10]. In the United States, for instance, 38% of the adult population are estimated to have prediabetes [11].

A follow-up study among Finnish adults investigated whether number of teeth could predict the incidence of cardiovascular diseases, diabetes and all-cause mortality (all confirmed through national registers) [4]. The capacity of number of teeth to predict emerging diabetes diagnosis was evident: a higher number of missing teeth indicated an elevated risk for diabetes.

Previously, while investigating smoking and tooth loss, the number of missing teeth tended to be higher in subjects with diabetes than in those without [12]. The association between diabetes (self-reported responses combined with information from different registers) and the number of missing teeth, however, showed no statistical significance due to relatively low number of participants in the study.

Although numerous studies have examined diabetes and tooth loss, evidence of a relation with overall glucose metabolism is tenuous. By making use of detailed clinically verified information on different states of diabetes, we aimed to investigate whether even prediabetic glucose metabolism associates with tooth loss in relatively healthy middle-aged Finnish adults.

2. Material and Methods

2.1. Study design

This cross-sectional study used data from the longitudinal Northern Finland Birth Cohort Study 1966 (NFBC1966), which consists of a comprehensive sample of individuals from the two northernmost provinces of Finland (Lapland and Oulu) whose expected year of birth was 1966 (12 068 mothers, 12 231 children, 96.3% of all births in the region) [13]. The cohort members participated in regular monitoring since their mothers' pregnancy. The Ethics Committee of the Northern Ostrobothnia Hospital District in Oulu, Finland approved the study protocol, which followed the principles of the Declaration of Helsinki. Participation was voluntary and all participants provided their written informed consent. The data were handled on a group level only, and identification codes replaced participants' personal information.

This study used data from the 46-year follow-up (carried out in 2012–2014), which included a mailed survey and a comprehensive in-person clinical health examination. The questionnaires and invitations to health examinations were mailed to all who lived in Finland and whose addresses were known at the beginning of 2012 (n = 10 321). In all, 5950 participants provided self-reported information on number of teeth, and 5120 participants on their diabetic state (defined by previously known and OGTT diagnoses).

2.2. Glucose tolerance and diabetes

Participants underwent a 2-h oral glucose tolerance test (OGTT), carried out as part of the clinical examinations, after an overnight (12 h) fasting period. Exclusion criteria from the OGTT included medication for diabetes or a capillary blood glucose level > 8.0 mmol/l measured immediately before the test. Both serum insulin and plasma glucose levels were measured at baseline and at 30, 60 and 120 min after an intake of 75 g glucose. Plasma glucose was analysed by an enzymatic dehydrogenase method (Advia 1800, Siemens Healthcare Diagnostics, Tarrytown, NY, USA) and serum insulin by a chemiluminometric immunoassay (Advia Centaur XP, Siemens Healthcare Diagnostics, Tarrytown, NY, USA). The samples were analysed in NordLab Oulu, a testing laboratory (T113) accredited by Finnish Accreditation Service (FINAS) (EN ISO 15189).

Glucose tolerance status was classified according to the WHO criteria: (i) normal glucose tolerance (NGT) was defined as a fasting plasma glucose (FPG) level < 6.1 mmol/l and a 2-h glucose level < 7.8 mmol/l, (ii) impaired fasting glucose (IFG) as an FPG level 6.1–6.9 mmol/l and a 2-h glucose level < 7.8 mmol/l, (iii) impaired glucose tolerance (IGT) as an FPG level < 7.0 mmol/l and a 2-h glucose level 7.8–11.0 mmol/l and (iv) screening-detected diabetes mellitus (ScDM) as an FPG level $\geq$ 7.0 mmol/l and/or a 2-h glucose level $\geq$ 11.1 mmol/l. Previously known diabetes (PrDM) was determined by combining and verifying information from numerous sources: participants' self-reported diagnoses and medications, hospital outpatient and inpatient registers, and medication registers from the Social Insurance Institution of Finland. These registers include diagnoses made by doctors.

In addition, we defined insulin sensitivity using the Matsuda index (ISI), defined as ISI = 10 000/sqrt (FPG * FSI * (Mean OGTT glucose concentration) * (Mean OGTT insulin concentration)), where sqrt = square root and FSI = fasting serum insulin [14].

2.3. Number of teeth

Subjects reported the number of teeth they had at the age of 46 with no distinction between third molars and other teeth. For our analyses, we converted this measure into an ordinal variable with three categories: 0–24, 25–27 or 28–32 [15].

2.4. Oral health-related factors

The mailed questionnaire enquired about education, smoking, use of oral hygiene products and eating habits. Participants reported their level of education at the age of 46; we used this information to form a three-class ordinal variable: (1) 'basic education' included those who had not graduated from high school and had no formal vocational qualification, (2) 'secondary education' included those who had graduated from high school or vocational school, and (3) 'higher