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Prevalence of taste and smell impairment in adults with diabetes: A cross-sectional analysis of data from the National Health and Nutrition Examination Survey (NHANES)

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ABSTRACT

Aim: This study investigates the prevalence of smell and taste impairment in adults with diabetes and potential risk factors for sense deterioration and its influence of daily food intake.

Methods: Data from the NHANES 2013-2014 were analyzed. Smell impairment was defined as failing to identify ≥ 3 of 8 odors in NHANES Pocket Smell Test. Taste impairment was defined as being unable to identify quinine or NaCl in NHANES Tongue Tip and Whole-mouth Test.

Results: A total of 3204 people (428 patients with diabetes, 2776 controls) were suitable to be included. The prevalence of smell impairment in patients with diabetes was higher compared to the controls: 22% versus 15% ($p < 0.001$). The difference prevailed after adjustment for age, BMI, alcohol misuse and smoking status. Taste was not impaired in patients with diabetes ($p = 0.29$). Patients with diabetes and smell impairment had a lower daily calorie intake compared to patients with diabetes and normal smell function. The duration of diabetes, diabetic complications and other potential risk factors were not associated with smell dysfunction.

Conclusions: Smell dysfunction appears with a higher prevalence in patients with diabetes, and this seems to negatively affect daily food intake.

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1. Introduction

Smell and taste dysfunction affects 13.5% and 17.3%, respectively, of the US population aged 40 years and older [1]. The taste and smell of foods and beverages guide appropriate food intake, and warn of environmental hazards [2].

Several studies have reported smell and taste impairment in patients with diabetes [3–11] and a significant correlation between the level of blood glucose concentration and taste thresholds has been documented [12]. However, studies investigating this have small populations (≤ 210 people in each) and produced varying results. The association between impairment of smell and taste in patients with diabetes and daily calorie intake has to our knowledge never been investigated. Relevantly, taken into account that the senses of smell and taste play a key role in the sensory effects on choice and food intake [13] and it is known that low-carbohydrate diet produce clinical improvements in the management of type 2 diabetes and comorbidity [14].

Previous studies have investigated correlating factors to sense impairment. Smell dysfunction has been correlated to a large range of lifestyle and socio-economic factors besides diabetes, age, gender, hypertension, BMI, blood triglycerides, neuropathy, and microvascular diseases [1,3,6,15]. Taste impairment has been correlated to local and systemic diseases such as diabetes, impaired glucose tolerance as well as alcohol consumption, smoking, medications, lifestyle, and socio-economic factors [4,15]. However, these studies did not focus on patients with diabetes. Again, no investigations of a possible association between smell and taste impairment and daily calorie intake were made. Thus, there is a need for controlled studies of smell and taste impairment and its influence of food intake in patients with diabetes.

The aim of this study is to investigate the prevalence of smell and taste impairment in adults with diabetes mellitus compared to a general non-diabetes population of the US. In addition, to investigate the prevalence of potential risk factors for sense deterioration and the association between sense impairment and daily food intake.

2. Methods

2.1. Study design

To investigate the prevalence of smell and taste impairment and the association between sense impairment and daily food intake, we use a representative dataset collected from the National Health and Nutrition Examination Survey (NHANES 2013-2014). In the cross-sectional analysis, we first compared patients with diabetes with controls. The collected data including smell and taste impairments and potential risk factors. In sub-analyses, we investigate the differences between the people with and without sense impairment in the two subgroups: Patients with diabetes and the control group.

2.2. Participants

Data from NHANES were collected by the National Center for Health Statistics from 2013 to 2014. In 2013-2014, NHANES

assess the health and nutritional status of people in the USA from 30 different survey locations. 14,332 persons were selected, of whom 10,175 completed the interview and 9813 were examined. All participants with taste and smell examination were included. The taste and smell examination was performed among participants aged 40 years and older. Participants were excluded from smell and taste examinations if they were currently pregnant or breastfeeding, and moreover excluded from the taste examination if they were allergic to quinine and/or unable to correctly rate the brightness of a standard series of three lights in an LED luminescence panel.

Participants with suitable data for the definition of diabetes or control group and were included. Diabetes were defined as answering yes to the question “Has a doctor told that you have diabetes” and $HbA1c \geq 6.5\%$ (48 mmol/mol) measured in blood test or self-reported treatment with antidiabetic medicine (pills and/or insulin) in a questionnaire independent of $HbA1c$. The control group were defined as answering no to the question “Has a doctor told that you have diabetes”, $HbA1c < 6.5\%$ and no self-reported treatment with antidiabetic medicine. Furthermore, the inclusion criteria was suitable data of food intake including daily calorie intake (kcal), and daily intake of protein, carbohydrates, sugar, fat, and sodium based on foods and beverages consumption during the 24-h period prior to an dietary interview.

2.3. Smell assessment

Smell function was assessed by the NHANES Pocket Smell Test [16]. The test contained eight odorants (chocolate, strawberry, smoke, leather, soap, grape, onion, and natural gas), which were presented in a fixed order. The participant released the smell by scratching the presented odor test strip, after which the participant smelled the odor and tried to identify it. Above each odorant strip, there was a list of four possible responses, and the participant was required to choose one of them. Smell impairment was defined as not being able to correctly identify three or more of the eight odorants.

2.4. Taste assessment

The taste examinations included NHANES tongue tip taste and whole-mouth taste test [16]. The participant was presented with two tastings (1 mM quinine as a bitter taste and then 1 M NaCl as a salt taste) in a fixed presentation order at the tip of the tongue with a cotton swab applicator. After presentation, the participant was asked to keep their tongue out and rate the taste intensity and identify it as salty, bitter, sour, some other taste, or no taste. Taste intensity was obtained from the participants by the generalized labeled magnitude scale (gLMS), used for rating perceived taste intensities [17].

Afterwards the participant was presented with three tastings (0.32 M NaCl, 1 mM quinine, 1 M NaCl) in the whole mouth in one of two randomized presentation orders. The participant was instructed to swish the 10 ml tasting solution in the mouth for three seconds, spit it out, and then provided a taste intensity and identified it as salty, bitter, sour, some other taste, or no taste. The mouth was rinsed with tap water between all the tests.

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