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Diabetes-related foot ulcers and associated factors: Results from the Nord-Trøndelag Health Survey (HUNT3) (2006–2008)☆

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ABSTRACT

Aim: To determine the proportion of people with diabetes reporting a history of foot ulcer and investigate associated factors and healing time in the Nord-Trøndelag Health Survey (HUNT3), Norway.
Methods: In 2006–2008, all inhabitants in Nord-Trøndelag County aged ≥20 years were invited to take part in this population-based study; 54% ($n = 50{,}807$) attended. In participants reporting to have diabetes we examined the relationships between foot ulcers requiring more than 3 weeks to heal (DFU) and sociodemographic, lifestyle and clinical variables using logistic regression analysis.
Results: Among participants with diabetes, 7.4% (95% confidence interval (CI) 6.2%–8.6%) reported a DFU. The median healing time was 6.0 weeks. In the final model, factors associated with a DFU were age ≥75 years (odds ratio (OR) 2.3, 95% CI 1.4–3.7), male sex (OR 2.0, 95% CI 1.3–3.1), waist circumference ≥102 cm (men) or 88 cm (women) (OR 1.95, 95% CI 1.2–3.2), insulin use (OR 2.1, 95% CI 1.3–3.4) and any macrovascular complication (OR 1.8, 95% CI 1.1–2.8).
Conclusions: The proportion of people with diabetes reporting a DFU was 7.4%, associated factors were age ≥75 years, male sex, waist circumference ≥102 cm (men) or 88 cm (women), insulin use and any macrovascular complication. The median healing time was 6 weeks.

1. Introduction

The lifetime incidence of diabetes-related foot ulcers has been estimated to be 25% (Singh, Armstrong, & Lipsky, 2005). A history of diabetes-related foot ulcer may increase the risk of new ulceration by as much as 70% within 5 years (Apelqvist & Larsson, 2000). Diabetes-related foot ulcers are associated with lower health-related quality of life (Ribu, Hanestad, Moum, Birkeland, & Rustoen, 2007) and excess mortality (Iversen et al., 2009). A diabetes diagnosis increases the risk of amputation by up to 34 times (Kapelrud, 2006). The cost burden of diabetes-related foot ulcers is significant for the individual and the society (Cavanagh et al., 2012). Hence, focusing on factors that might delay or prevent the occurrence of diabetes-related foot ulcers is important.

The St. Vincent Declaration of 1989 stated that rate of limb amputations should be reduced by one half (Diabetes Care Research in Europe, 1990). The Norwegian Society of General Practitioners Diabetes Group (NSAM) followed up this focus in 1995, simultaneously with the introduction of stricter guidelines on preventing cardiovascular disease among people with diabetes (American Diabetes Association (ADA), 2012; Claudi, 1995; Norwegian Health Directorate, 2009). In recent years, new treatment guidelines have been introduced in primary care for people with type 2 diabetes. At the same time, major improvements in health outcomes such as mean glycated hemoglobin (HbA_{1c}), systolic blood pressure and cholesterol are evident (Cooper et al., 2009). However, it is unclear whether these strategies and improvements have significantly affected comorbidity in general and more specifically the proportion of diabetes-related foot ulcers in Norway.

Identifying risk factors and factors associated with a more demanding chronic condition is an important area of priority within the quality of diabetes care. More knowledge about factors associated with comorbid conditions and complications may contribute to identifying vulnerable populations needing supportive interventions and more targeted preventive strategies.

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Thus, the aim of this study was to determine the proportion of people with type 1 and type 2 diabetes reporting a history of foot ulcer in HUNT3 (2006–2008), to investigate factors associated with diabetes-related foot ulcers and to report healing time.

2. Subjects, material and methods

This study is based on data from the third Nord-Trøndelag County Health Survey (HUNT3, 2006–2008). All 94,121 inhabitants of Nord-Trøndelag County, Norway aged 20 years and older at the time of screening were invited to participate (Krokstad et al., 2013), and 54% ($n = 50{,}807$) attended. Further details on the recruitment procedure have been published elsewhere (Krokstad et al., 2013). Each person was mailed a questionnaire to be completed and returned at attendance to the screening site where clinical examination was performed. The 2189 participants who answered affirmatively the question "Do you have or have you had diabetes?" were classified as having diabetes and invited to take part in the diabetes substudy involving an additional questionnaire they were given along with a prepaid, addressed envelope. A total of 1824 participants returned this questionnaire (response rate 83.3%). The 1751 participants who answered the question: "Have you had a foot ulcer that required more than 3 weeks to heal?" were included in the current study. Fig. 1 shows the participants characteristics.

We assessed sociodemographic variables (age, sex and marital status), lifestyle (physical inactivity and smoking) and clinical variables such as insulin use, duration of diabetes and whether they had ever used antihypertensive medication, self-reported eye problems diagnosed by a doctor as due to diabetes and macrovascular complications (history of stroke, myocardial infarction, angina pectoris and/or peripheral surgery) and history of amputation by questionnaires. Height, weight and waist circumference were measured by clinical examination at the first screening (Krokstad et al., 2013). Body mass index (BMI) was calculated as kilograms per meter squared (Krokstad & Knudtsen, 2011). Along with the diabetes-specific questionnaire, the participants received tubes for three consecutive first-morning urine samples and written instructions on how to collect the urine. All 1751 participants returned the urine samples, which were analyzed for albumin and creatinine. For participants who confirmed having diabetes, HbA_{1c} was analyzed by a non-fasting sample of blood at the second screening.

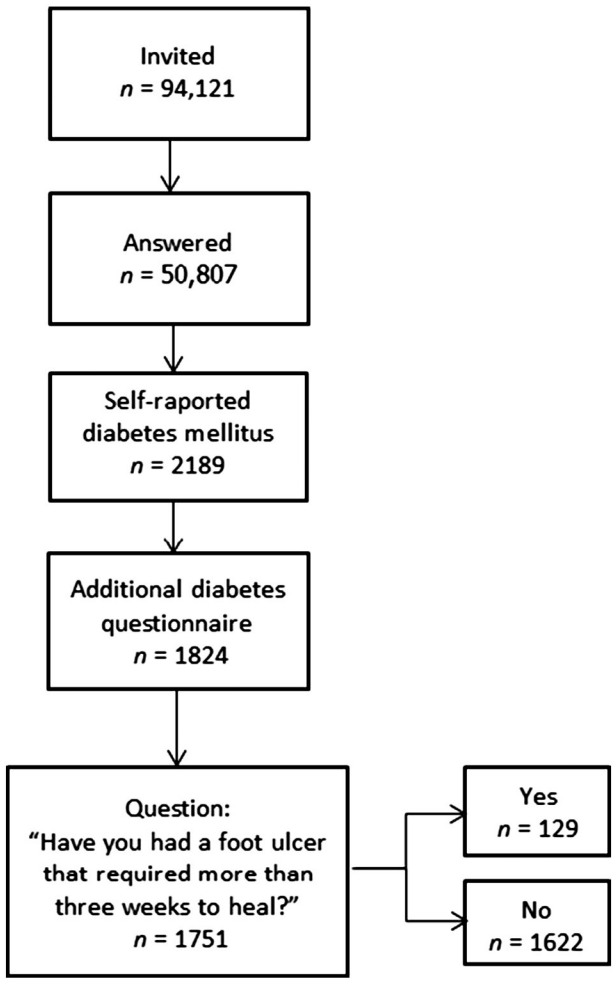

Fig. 1. Study participants.

We set generated dichotomized cut-off points based on previous published risk estimates (Norwegian Health Directorate, 2009; Iversen et al., 2008; Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults, 2001; González et al., 2010; Iversen, 2009). We categorized and dichotomized the sociodemographic variables as follows; age at ≥75 years versus <75 years; marital status as single or alone (unmarried, widowed, divorced or separated) versus married; and height dichotomized at the median of each sex (≥176 cm for men and ≥162 cm for women).

For lifestyle variables, the waist circumference was dichotomized at ≥102 cm for men and ≥88 cm for women and physical inactivity as less than 1 h per week. Smoking was based on the question "Do you smoke?" Some participants marked two or more alternatives. Those who had any mark on one or more of the four other alternatives ("Yes, sometimes cigarettes (party/vacation, not daily)"; "Yes, sometimes cigar/cigarillos/pipe"; Yes, cigarettes daily"; "Yes, cigar/cigarillos/pipe daily") were categorized as current smokers. For the regression model, never smokers and former smokers were grouped as not current smokers.

Participants were assigned "did not use" for insulin if they answered that they used tablets for their diabetes and concurrently did not answer the question about insulin use. We dichotomized the duration of diabetes as ≤10 years versus >10 years. We defined microalbuminuria as an albumin–creatinine ratio >3 mg/mmol in at least two of three urine samples. We categorized diabetes complications as follows: microvascular complications (microalbuminuria, self-reported eye problems due to diabetes), macrovascular complications (self-reported history of stroke, myocardial infarction, angina pectoris and/or peripheral surgery) and any lower limb amputation (toe/foot, calf/knee and/or thigh).

2.1. Statistical analyses

To compare respondents by foot ulcer history, we used *t*-tests for continuous variables: age, height, BMI, waist circumference and HbA_{1c}. We used chi-square tests for nominal variables: sex, marital status, physical inactivity, smoking, insulin, antihypertensive medication and micro- and macrovascular complications. We used Fisher's exact test instead of chi-square when the assumption of expected counts was not met (for the variables peripheral surgery and any lower-limb amputation). We used logistic regression to generate odds ratios (OR) and 95% confidence intervals (CI) to determine which independent variables were associated with a history of foot ulcer. We selected variables for the regression model a priori based on empirical relevance and theory before performing any statistical analysis. In a hierarchical model, we added four sets of variables (demographic, lifestyle, clinical and complication variables, respectively) one at a time. The change in effect estimates generated by adding each variable set into the equation is shown.

We conducted statistical analysis using SPSS version 19. We assessed the statistical significance with a two-sided *P*-value of 0.05.