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# Regularity of Preventive Foot Care in Persons With Diabetes: Results From the Nord-Trøndelag Health Study

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**Abstract:** The purpose of the present study was to examine the regularity of preventive care for persons with diabetes in the Nord-Trøndelag Health Study to identify associated demographic, lifestyle, and disease-related factors. Among 1,972 persons with diabetes, 1,459 (74%) answered questions related to preventive foot care. The final sample included 1,312 persons with known diabetes, but without a self-reported history of foot ulcer. Almost 85% reported receiving regular clinical diabetes examinations, 31.7% reported regular foot inspection by health care personnel, and 66.3% reported foot self-inspection. Only 58.8% reported regular clinical diabetes examination combined with foot inspection. Males, patients not using insulin, and those with shorter diabetes duration or macrovascular complications were more likely to report less regular preventive care.  Res Nurs Health 31:226–237, 2008

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Foot ulcers and amputations are major causes of morbidity and disability for people with diabetes (Mason et al., 1999). The emotional, physical, and economic costs associated with foot ulcers and amputations are considerable (Singh, Armstrong, & Lipsky, 2005). Ongoing long-term prevention should be a priority of care, because early recognition and management of risk factors for

The Nord-Trøndelag Health Study (the HUNT study) is a collaboration between the HUNT Research Center, Faculty of Medicine, the Norwegian University of Science and Technology (NTNU), Verdal, Norwegian Institute of Public Health, Oslo and the Nord-Trøndelag County Council. Marjolein Iversen was supported by the Bergen University College to complete this study. We thank Katrina Krause for technical assistance.

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ulcers and amputations can prevent or delay the onset of these adverse outcomes (Abbott et al., 2002; American Diabetes Association [ADA], 2006; Claudi et al., 2005). A primary aspect of prevention is regular foot inspection by a health care professional. The purpose of this study was to investigate preventive foot care practices for persons with diabetes in a large population based health study in Norway.

Frameworks for diabetes care, such as the chronic care model, have been developed to promote prevention (Glasgow, Orleans, Wagner, Curry, & Solberg, 2001). Recent research testing the model has demonstrated that the chronic care model is effective in promoting positive outcomes for people with diabetes (Bodenheimer, Wagner, & Grumbach, 2002). Care based on the model has been shown to improve diabetes knowledge and empowerment scores and to reduce $HbA_{1c}$ values (Nutting et al., 2007; Piatt et al., 2006). Elements of the model include planned regular interactions between a prepared health care team and an informed patient.

This framework is based on previous research, which has shown that patients' role in managing their disease and engaging in self-care is important to prevent complications (Lorig, 1993). The patient needs to be well informed to maintain good self-care, and patient/provider collaboration is needed to support the patient's self-management (Bodenheimer, Lorig, Holman, & Grumbach, 2002; Reiber & Raugi, 2005; Renders et al., 2001). The Diabetes Attitudes Wishes and Needs (DAWN) study (International DAWN Advisory Panel et al., 2006) assessed patient and provider perceptions of diabetes care through self-reported data from several countries in Asia, Europe, and North America, as well as Australia. Results from this study indicate that there is a need for improvement in applying the chronic care model to the treatment and prevention of diabetes in all countries studied and that each country should develop its own priorities for improving diabetes care.

National and international guidelines recommend an annual foot examination for all patients with diabetes (ADA, 2006; Claudi et al., 1995, 2005; International Working Group on the Diabetic Foot, Apelqvist, Bakker, van Houtum, Nabuurs-Franssen, et al., 1999). Nevertheless, this goal has been difficult to attain (Ahluwalia et al., 2000; De Berardis et al., 2004, 2005). Guideline nonadherence occurs, in part, because health care providers are unable to follow and assess patients' needs for support over time (Claudi, Cooper, & Daae, 2000; Østbye et al., 2005; van Houtum, 2005).

The risk of foot ulcers is increased in people who are older, male, living alone, have had diabetes more than 10 years, have poor glucose control, are current smokers, and have cardiovascular, retinal, or renal complications (ADA, 2006; Claudi et al., 1995, 2005; International Working Group on the Diabetic Foot et al., 1999). Waist circumference correlates with diabetic neuropathy, which is a risk factor for foot ulcers (Al-Mahroos & Al-Roomi, 2007). Past history of foot ulcer and current foot ulcer are the strongest independent risk factors for a new foot ulcer (Abbott et al., 2002). Thus, people with one or more already existing high-risk foot conditions (e.g., a history of foot ulcer, peripheral neuropathy, or peripheral vascular disease) should be evaluated more frequently for the development of complications than other persons with diabetes. In addition to demographic characteristics, lifestyle factors, and disease related variables, there are also health care setting variables that are related to foot care practices. People tend to have their feet inspected more regularly if they are followed in specialty clinics (De Berardis et al., 2005).

In line with national and international guidelines, optimal regularity means that people with diabetes should be inspected at least annually, but for people at high-risk inspection should be more frequent (ADA, 2006; Claudi et al., 1995, 2005). Norwegian guidelines advise that foot inspection should be a part of routine care every 3 or 4 months for those at high-risk (Claudi et al., 1995, 2005). Regular foot inspections may provide education to increase patients' awareness of the problem, their aptitude for self-management, and their ability to decrease the incidence of minor foot lesions (Apelqvist & Larsson, 2000). The feet of a diabetic patient should be inspected at every visit to primary health care and specialist care providers, and also at every visit from home care services (Apelqvist & Larsson).

In this study, *preventive foot care practice* was defined as including both (a) regular clinical diabetes examination involving physical examination by a physician, nurse, or other health care personnel and (b) regular foot inspection, either by health care personnel or by the patients themselves. These two central elements of prevention of foot complications are crucial for quality care (Bodenheimer, Lorig, et al., 2002; Reiber & Raugi, 2005; Renders et al., 2001). The aim of the study was to assess preventive foot care practices for people with diabetes in Norway. The research questions were:

1. "What is the regularity of preventive foot care among persons with diabetes in Norway, and is there any relationship between health care

personnel's regular inspection of patient's feet and regular self-inspections?''

2. ''What demographic factors (age, sex, marital status, and education), lifestyle factors (waist circumference, current smoker, member of Norwegian Diabetes Association [NDA], attended a diabetes course), and disease-related factors (diabetes duration, $HbA_{1c}$, insulin treatment, microvascular and macrovascular complications) are associated with preventive foot care?''

## METHOD

### Design

Preventive foot care practice was examined in a sample of adults with diabetes from a large, population-based health survey. The design and method of the second Nord-Trøndelag Health Study (HUNT2) are described in detail elsewhere (Holmen et al., 2003). HUNT2 was a comprehensive health study of public health issues covering a wide range of topics related to chronic illnesses. HUNT2 was carried out during 1995–1997 in the Nord-Trøndelag County. This county is large and fairly representative of Norway as a whole, except that it has no large cities, and the average levels of education and income are somewhat lower than the national averages. The population is stable and ethnically homogenous, with only a small percentage (3%) of non-Whites (Holmen et al.).

The HUNT2 study was approved by the Norwegian Data Inspectorate and by the Regional Committee for Medical Research Ethics. Participation was voluntary, and each participant signed a written consent form. The study complied with the Declaration of Helsinki. The current analyses were exempted from full review by the Duke University Medical Center Institutional Review Board.

### Sample

All inhabitants of the county aged 20 years and older at the time of screening were invited to participate in HUNT2 ($N = 92{,}434$). Each person was mailed a questionnaire together with an invitation to attend a clinical examination. Of the total number invited, 65,604 individuals (71%) filled in the questionnaire and attended the examination. This brief clinical examination included anthropometric measurements. In addition, a nonfasting sample of blood was drawn from 65,200 people in the sample. A total of 1,972 respondents (~3%) answered affirmatively to the question: ''Do you have, or have you had, diabetes?'' and were invited to take part in our ancillary diabetes study (Fig. 1).

This ancillary study involved an additional questionnaire on diabetes-related issues including diagnosis, treatment, duration, diabetes examination, foot inspection, self-care, and complications, including a history of foot ulcer. Participants were asked to complete this questionnaire at home and return it by mail, using a pre-stamped addressed envelope. A total of 1,692 persons with diabetes returned their questionnaires (85.8% response rate).

Of those who returned the diabetes questionnaire, 1,459 persons answered two or more items from the following domains: (a) regular diabetes examination, (b) regular foot inspection by health care personnel, and (c) regular self-inspection of their feet. To avoid combining examinations for prevention of foot complications with follow-up examinations of those who already might have foot ulcers, respondents who reported a history of foot ulcer ($n = 147$) were excluded from the screening sample. The final sample included 1,312 persons with known diabetes, but without a self-reported history of foot ulcer. The sample derivation is shown in Figure 1.

Respondents with diabetes who completed the diabetes questionnaire related to the regularity of preventive foot care ($n = 1{,}459$) were compared with respondents with diabetes who did not complete these questions ($n = 513$). Those who did not complete the diabetes questionnaire were more likely to be women, older and single, to have less education, a larger waist circumference, microalbuminuria, and a history of stroke. The completion rate was 74% (1,459/1,972).

### Diabetes Classification

The HUNT2 study included analysis of a nonfasting serum sample for glucose in all persons attending the screening; for those who reported diabetes, a blood sample also was analyzed for $HbA_{1c}$. They were also given a new appointment to collect the following: fasting blood glucose, C-peptide, and GAD antibodies (74.8% participation). Diabetes classification was defined as follows: type 1 diabetes (anti-GAD $\geq .08$ units or anti-GAD $< .08$ and C-peptide $< 150$ pmol/L),

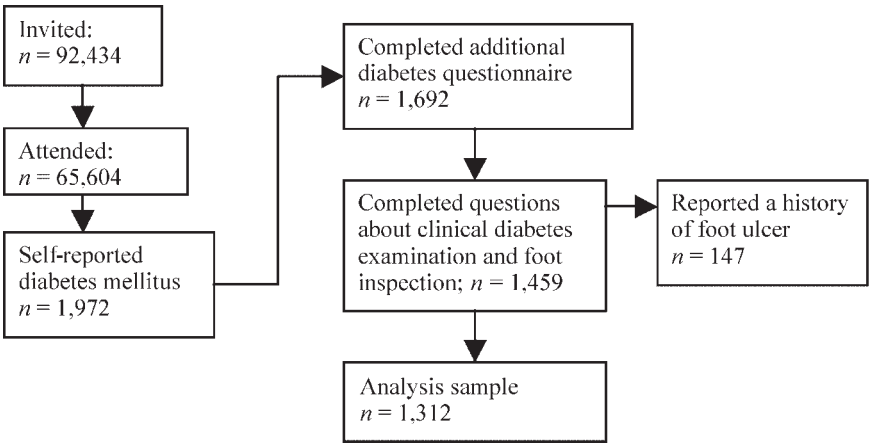


**FIGURE 1.** Study participants.

type 2 diabetes (anti-GAD $<.08$ and treated with diet only or oral antidiabetic medication or start of insulin treatment 12 months or more after the diabetes diagnosis). At the new appointment seven patients stated that they had transient diabetes during a previous pregnancy and were excluded. As recommended by the World Health Organization (WHO, 1999), persons with latent autoimmune diabetes of the adult (LADA) were combined with those classified as type 1 diabetes. The final sample for analysis was 1,312 persons with diabetes without a history of foot ulcer.

## Independent Variables

Demographic variables: Age was grouped as follows: $<65$ years, 65–74 years, $\geq 75$ years. Marital status (*single vs. not single*), and education (*compulsory education [$<10$ years] vs. high education [$\geq 10$ years]*) were dichotomized.

Lifestyle variables: Waist circumference (measured at the umbilical level) was dichotomized as men $\geq 102$ and women $\geq 88$ cm, respectively (Lean, Han, & Morrison, 1995). Current smoker (*yes/no*) was dichotomized. Diabetes self-education was measured with two questions: "Have you ever attended a course or meeting about diabetes?" (*yes/no*) and "Are you a member of the Norwegian Diabetes Association?" (*yes/no*).

Disease-related variables: Insulin use was dichotomized (*did use/did not use*). Those who did not answer the question about insulin use, but answered that they used tablets for their diabetes, were coded *did not use*. To be consistent with both international (ADA, 2006) and national guidelines (Claudi et al., 1995, 2005) we categorized $HbA_{1c}$ as $<7.5$; 7.5–9.0; and $>9.0$, based on published risk estimates (Lavery, Armstrong, Vela, Quebedeaux, & Fleischli, 1998). Complications related to diabetes were microvascular (microalbuminuria, self-reported eye problems due to diabetes) and macrovascular (history of stroke, myocardial infarction, angina pectoris, and peripheral surgery). Three consecutive first morning urine samples were analyzed for albumine and creatinine. Albumin/creatinine ratio (ACR) $\geq 2.5$ mg/mmol in at least two of the three urine samples was used to define microalbuminuria (MA; Hallan, Romundstad, Kvenild, & Holmen, 2003).

Health care setting variable: Physician was coded either as *general practitioner* or *hospital specialist*.

## Primary Outcome

Regularity of preventive foot care was determined as a combination of report of regular clinical diabetes examination and endorsement of one or both of the following: regular foot inspection by health care personnel (doctor, nurse, or podiatrist) or regular self-inspection of feet.

Regular clinical diabetes examination was indicated by affirmative responses to one of two questions: "Do you see a doctor for regular check-ups for your diabetes?" or "If not, do you see a nurse or other health care personnel for check-ups for your diabetes?" Regular foot inspection by a doctor, podiatrist, nurse, or home care nurse was coded as *regular foot inspection by health care personnel*. Regular foot inspection by self or others who were not health care personnel was coded as *regular self-inspection of their feet*. The

term regular foot inspection was not predefined in the questionnaire. However, we asked the patients who confirmed regular foot inspections to indicate the intervals between the inspections.

## Data Analysis

To analyze the first research question: ''What is the regularity of preventive foot care among persons with diabetes in Norway and is there any relationship between health care personnel's regular inspection of respondents' feet and regular self-inspections?'' descriptive statistics (*mean*, *SD*, percentages) were calculated (Table 1) for demographic, lifestyle and disease-related variables, and variables related to health care setting, diabetes examination and foot inspection. Chi-square test was used to determine whether the outcome measures of health care personnel's regular inspection of respondents' feet and regular self-inspections were related.

To analyze the second research question: ''What are the demographic, lifestyle and disease-related factors associated with preventive foot care?'' bivariate analysis and multiple logistic regression were performed.

In the bivariate analysis $\chi^2$ tests were used to compare variables by subgroups defined by type of examination, (a) regular foot inspection by health care personnel, (b) regular foot inspection by patients themselves, or (c) regular monitoring (regular clinical diabetes examination combined with regular foot inspection by either a health care provider or the patient). Sixteen separate tests were performed (Table 2), and therefore significant findings should be interpreted with caution. Because these are secondary analyses of existing data and can be considered exploratory rather than confirmatory, we decided not to adjust for multiple testing. Such adjustment would have increased the possibility of rejecting true relationships.

Our modeling strategy started with preliminary, separate multivariate logistical models for each of

**Table 1. Sample Characteristics ($n = 1,312$)**

| Characteristics | *M* (*SD*) | % | *n* |
|---|---|---|---|
| Demographic variables | | | |
| Age (years) ($n = 1,312$) | 65.5 (13.6) | | |
| Male sex ($n = 1,312$) | | 49.6 | 651 |
| Height (cm) ($n = 1,288$) | 167.9 (9.6) | | |
| Marital status (single/alone) ($n = 1,310$) | | 38.2 | 501 |
| Education ($< 10$ years) ($n = 1,162$) | | 61.6 | 716 |
| Lifestyle variables | | | |
| Waist circumference (cm) ($n = 1,297$) | 94.9 (12.0) | | |
| Current smokers ($n = 1,307$) | | 17.5 | 229 |
| Member of the Norwegian Diabetes Association (NDA) ($n = 1,288$) | | 28.8 | 371 |
| Attended a course or meeting about diabetes ($n = 1,165$) | | 21.3 | 248 |
| Disease-related variables | | | |
| Duration of diabetes (years) (median) ($n = 1,281$) | | 6 | |
| Insulin treatment ($n = 1,306$) | | 31.9 | 416 |
| $HbA_{1c}$ (%) ($n = 1,281$) | 8.1 (1.7) | | |
| Subgroups of diabetes | | | |
| Type 1 ($n = 1,002$) | | 17.2 | 172 |
| Type 2 ($n = 1,002$) | | 82.8 | 830 |
| Microvascular complications | | | |
| Microalbuminuria ($n = 1,236$) | | 27.2 | 336 |
| Eye problems due to diabetes ($n = 1,245$) | | 12.8 | 159 |
| Any microvascular complication ($n = 1,312$) | | 33.8 | 444 |
| Macrovascular complications | | | |
| Self-reported stroke ($n = 1,277$) | | 4.7 | 60 |
| Self-reported myocardial infarction ($n = 1,291$) | | 12.4 | 160 |
| Self-reported angina pectoris ($n = 1,282$) | | 18.7 | 240 |
| Peripheral vascular surgery ($n = 1,273$) | | 2.9 | 37 |
| Any macrovascular complication ($n = 1,312$) | | 27.6 | 362 |
| Health care setting | | | |
| General practitioner ($n = 1,058$) | | 84.7 | 896 |
| Hospital doctor ($n = 1,058$) | | 15.3 | 162 |

*Note*: Total sample *n*'s differ somewhat based on varying completion of the different tests/questionnaires.

**Table 2. The Proportion (%) of Persons With Diabetes Reporting Clinical Examinations and Foot Inspections Within Different Subgroups; Bivariate Analyses (n = 1,312)**

| Characteristics | *n* | Regular clinical diabetes examination (*n* = 1,096) % | Regular foot inspection | | Clinical diabetes examination combined with regular foot inspection (*n* = 722) % |
|---|---|---|---|---|---|
| | | | By health care personnel (*n* = 365) % | Self-inspection (*n* = 1,003) % | |
| Demographic variables | | | | | |
| Age | | | | | |
| < 65 years | 503 | 85 | 25 | 67 | 61 |
| 65–74 years | 441 | 85 | 34 | 68 | 59 |
| ≥ 75 years | 368 | 83 | 38* | 62 | 55 |
| Sex | | | | | |
| Female | 661 | 86 | 38 | 69 | 63 |
| Male | 651 | 83 | 26* | 64 | 55* |
| Single | | | | | |
| No | 809 | 84 | 29 | 65 | 57 |
| Yes | 501 | 86 | 37* | 68 | 61 |
| Education | | | | | |
| < 10 years | 716 | 84 | 36 | 66 | 59 |
| ≥ 10 years | 446 | 86 | 24* | 69 | 62 |
| Lifestyle variables | | | | | |
| Waist circumference | | | | | |
| < 102/88 cm | 692 | 85 | 27 | 66 | 59 |
| ≥ 102/88 cm | 605 | 84 | 36* | 67 | 59 |
| Current smoker | | | | | |
| No | 1,078 | 85 | 32 | 66 | 59 |
| Yes | 229 | 82 | 29 | 66 | 56 |
| Member of NDA | | | | | |
| No | 917 | 82 | 27 | 61 | 53 |
| Yes | 371 | 91* | 42* | 79* | 73* |
| Attended a diabetes course/meeting | | | | | |
| No | 917 | 83 | 27 | 63 | 55 |
| Yes | 248 | 91* | 49* | 80* | 76* |
| Disease-related variables | | | | | |
| Duration | | | | | |
| ≤ 10 years | 849 | 83 | 27 | 62 | 54 |
| > 10 years | 432 | 88* | 41* | 75* | 69* |
| $HbA_{1c}$ | | | | | |
| < 7.5 | 536 | 81 | 28 | 62 | 53 |
| 7.5–9.0 | 424 | 88 | 30 | 68 | 63 |
| > 9.0 | 321 | 85* | 40* | 70* | 62* |
| Insulin treatment | | | | | |
| No | 890 | 81 | 26 | 61 | 53 |
| Yes | 416 | 91* | 44* | 78* | 73* |
| Microalbuminuria | | | | | |
| No | 900 | 84 | 30 | 66 | 58 |
| Yes | 336 | 84 | 34 | 68 | 60 |
| Eye problems due to diabetes | | | | | |
| No | 1,086 | 84 | 30 | 65 | 58 |
| Yes | 159 | 91* | 45* | 74 | 67* |
| Any microvascular complications | | | | | |
| No | 868 | 84 | 30 | 65 | 58 |
| Yes | 444 | 85 | 36* | 69 | 61 |
| Any macrovascular complications | | | | | |
| No | 950 | 85 | 30 | 68 | 61 |
| Yes | 362 | 82 | 37* | 61* | 54* |
| Health care setting | | | | | |
| GP | 896 | 92 | 34 | 66 | 63 |
| Hospital doctor | 162 | 97* | 37 | 83* | 79* |

*$p < .05$.

the following outcomes: (a) regular clinical diabetes examination, (b) regular foot inspection by health care personnel, and (c) regular foot inspection by patients themselves (results of the preliminary models are not shown). In these preliminary models, education was inconsistently related to these three outcomes, and was therefore excluded from the final multivariate models. There was a highly significant association ($\chi^2$ [1, $N = 1{,}156$] = 218.4, $p < .001$) between the two diabetes self-education variables (attended a diabetes course or meeting and membership of the NDA), therefore only membership of the NDA was included in the final multivariate models. We related independent variables to the primary outcome variable (regularity of preventive diabetes foot care) by developing three increasingly complex models, adding one set of variables at a time (demographic, lifestyle, and disease-related variables; Table 3).

Statistical analyses were conducted using SPSS version 13.0. Statistical significance was assessed at the $p < .05$ level. Collinearity for the final model was assessed using the condition index (Kleinbaum, Kupper, Muller, & Nizam, 1998).

## RESULTS

### Regularity of Preventive Diabetes Foot Care and the Relationship Among Outcome Measures

Among the final sample of 1,312 respondents with diabetes without a history of foot ulcer, only 29.5% reported ever having had an inspection of their feet during a regular general practitioner (GP) visit. In total, 31.7% reported having had regular inspections of their feet by health care professionals, such as a GP, nurse, or podiatrist; regular self-inspection of feet was reported by 66.3% of respondents. Of the analysis sample, 84.6% reported regular clinical diabetes examination.

**Table 3. Relative Odds of Regular Preventive Diabetes Care (Regular Clinical Diabetes Examination Combined With Regular Foot Inspection); Multiple Logistic Regression**

| Variables | Model 1 OR (CI), $n = 1{,}310$ | Model 2 OR (CI), $n = 1{,}266$ | Model 3 OR (CI), $n = 1{,}203$ |
|---|---|---|---|
| Demographic variables | | | |
| Age <65 years[a] | | | |
| Age 65–74 years | .9 (.7–1.2) | 1.0 (.8–1.3) | 1.1 (.8–1.5) |
| Age ≥75 years | .7 (.5–.9) | .8 (.6–1.1) | .9 (.6–1.2) |
| Female[a] | | | |
| Male | .7 (.6–.9)* | .8 (.6–.97)* | .8 (.6–.99)* |
| Not single[a] | | | |
| Single | 1.2 (.9–1.5) | 1.2 (.9–1.5) | 1.1 (.9–1.5) |
| Lifestyle variables | | | |
| Waist circumference <102/88 cm[a] | | | |
| Waist circumference ≥102/88 cm | | .9 (.7–1.2) | 1.0 (.8–1.3) |
| Not current smoker[a] | | | |
| Current smoker | | .9 (.6–1.2) | .8 (.6–1.1) |
| Not member NDA[a] | | | |
| NDA member | | 2.3 (1.7–3.0)* | 1.8 (1.4–2.4)* |
| Disease-related variables | | | |
| Duration ≤10 years[a] | | | |
| Duration >10 years | | | 1.5 (1.1–2.0)* |
| $HbA_{1c}$ <7.5[a] | | | |
| $HbA_{1c}$ 7.5–9.0 | | | 1.3 (.99–1.8) |
| $HbA_{1c}$ >9% | | | 1.1 (.8–1.6) |
| No insulin[a] | | | |
| Insulin | | | 1.6 (1.2–2.2)* |
| No microvascular complications[a] | | | |
| Microvascular complications | | | 1.2 (.9–1.5) |
| No macrovascular complications[a] | | | |
| Macrovascular complications | | | .7 (.5–.96)* |

*Note*: Total sample *n*'s differ somewhat due to varying completion of the different tests/questionnaires.
[a]Reference category.
*$p < .05$.

However, only 58.8% reported regularity of preventive diabetes foot care in terms of regular clinical diabetes examination combined with regular foot inspection by health care personnel or self-inspection. The outcome measures were related to each other in that health care personnel's regular inspection of respondents' feet was positively associated with regular self-inspections ($\chi^2$ [1, $N = 844$] = 66.4, $p < .001$). The term *regular* was not predefined in the questionnaire, but respondents who reported that they had received regular foot inspections ($n = 365$) were asked to indicate the interval between each inspection by healthcare personnel. A total of 248 respondents (68%) reported a mean interval of 15.1 weeks (*SD*, 12.6) and a median of 12 weeks.

### Associated Factors

To identify associated demographic, lifestyle, and disease factors with those obtaining preventive foot care, and those not obtaining this care, we performed bivariate (Table 2) and multivariate analyses (Table 3). In the bivariate analyses, regular clinical diabetes examination was significantly related to insulin use, longer duration of diabetes, and higher levels of $HbA_{1c}$. Regular foot inspection by health care personnel was more frequently performed in persons who were older, female, single, or who had lower education ($< 10$ years), a larger waist circumference, longer duration ($> 10$ years) of diabetes, higher levels of $HbA_{1c}$, used insulin, had eye problems due to diabetes, and reported micro- or macrovascular complications. In bivariate analyses, all outcomes (i.e., clinical diabetes examination, regular foot inspection by health care personnel, regular foot self-inspection, and regularity of preventive diabetes foot care) were positively associated with diabetes self-education in terms of membership in the NDA or participation in a course/meeting about diabetes. Patients whose regular physician was hospital-based were also more likely to report regular monitoring.

Multivariate analyses were largely consistent with the bivariate analyses. In the final multivariate model (using regular preventive diabetes foot care, that is, regular clinical diabetes examination combined with any regular foot inspection, as the outcome variable) the following independent variables were significant: female gender, long diabetes duration ($> 10$ years), using insulin, and being a member of the NDA. Those who reported macrovascular complications were less likely to receive regular preventive diabetes foot care than those not reporting macrovascular complications (Table 3).

## DISCUSSION

### Regularity of Preventive Diabetes Foot Care and the Relationship Among Outcome Measures

Despite having universal access to the comprehensive health care system in Norway, only a little over half of the participants with diabetes in the large population-based HUNT2 survey reported regular preventive diabetes foot care. The findings indicate inadequate attention to diabetic foot prevention practices in this sample. Fortunately, there is increasing interest in diabetic foot care in Norway (Norges Diabetesforbund et al., 2005), and documentation of regular foot examinations will be included in a national diabetes register that is now underway. Furthermore, the potential to strengthen diabetes foot care is high, as almost 85% of people with diabetes in HUNT2 reported regular contact with the health care system.

In this and other studies only 27.2–51% of patients reported annual foot inspections by health care personnel (Ahluwalia et al., 2000; De Berardis et al., 2005; Tapp et al., 2004). However, in our study there was a positive relationship between regular inspection by healthcare personnel and regular self-inspection. These results are in line with the work from the QuED Study Group (De Berardis et al., 2004, 2005). The QuED Study Group also found that a substantial proportion of type 2 diabetic patients were not offered adequate foot care, even in the presence of major risk factors for lower limb complications. This suggests the importance of making health care personnel aware that their behavior during clinical encounters with diabetic patients may play a crucial role in guiding patient self-care, particularly in increasing the regularity of foot self-care activities.

The strong relationship between participants' reports of health care provider inspections and their own inspections is encouraging. Concordant with the Chronic Care Model, the results of the present study emphasize the key role of the patient as self-manager. Systematic use of guidelines may increase regularity of foot inspections.

### Associated Factors

Males and those with macrovascular complications were more likely than women and those without macrovascular complications to report less regular preventive foot care. Previous research has found that men with diabetes develop

foot ulcers more often than women (Abbott et al., 2002; Lavery et al., 1998). The findings in the present study support this, in that women were significantly more likely to get regular preventive foot inspections than men. This may explain why women show less vulnerability to foot ulceration.

Insulin use and longer diabetes duration ($>10$ years) were independently associated with regular preventive foot care in the multivariate analyses. This is in accordance with national and international guidelines (ADA, 2006; Claudi et al., 1995, 2005; International Working Group on the Diabetic Foot et al., 1999) that these groups were more likely to develop foot complications and hence should have more frequent check-ups. However, our findings suggest that persons with diabetes with shorter disease duration and those not treated with insulin might not be viewed as warranting regularity of preventive foot care. The results also suggest that the NDA may be well positioned to enhance the regularity of preventive foot care. On the other hand, it may be that those who have more problems managing diabetes are also more likely to join the NDA; this finding calls for careful interpretation and more study.

More research also is needed to understand better the issues for persons with macrovascular complications and how best to intervene with this vulnerable group to increase preventive foot care. Although the ADA recommendations (2006) call for close monitoring of patients with macrovascular complications, national guidelines (Claudi et al., 1995, 2005) do not spell this out.

With limited time available during practitioner–patient encounters, macrovascular complications are likely to be the primary focus in busy clinical practices, and the state of the feet easily may be overlooked (Lavery, Wunderlich, & Tredwell, 2005). Results from the present population-based study suggest insufficient attention to foot care inspections among persons with diabetes and their providers (ADA, 2006; Claudi et al., 1995, 2005; International Working Group on the Diabetic Foot et al., 1999). In a recent study examining guideline use for 10 chronic illnesses, a major barrier to providing recommended chronic disease care was the lack of time available to primary care physicians to implement practice guidelines (Østbye et al., 2005). Other barriers contributing to suboptimal diabetic foot care included long distances that patients must travel, making regular visits difficult, low interest in diabetic foot care by health care providers, untrained personnel, limited access to advanced centers when complications occurred, and variation in clinical decision-making (van Houtum, 2005). Previous researchers have suggested that the current health care system in the US was not sufficiently prepared to translate research into clinical practice and was inadequate to address the multitude of tasks facing clinicians, especially among patients with complex chronic illnesses (Bodenheimer, Wagner et al., 2002; Renders et al., 2001).

These problems also may exist in Norway, and to address them may require comprehensive system changes (Glasgow et al., 2001). These may include changing the composition of the practice team and the organization of visits and follow-up. Many effective interventions enhance practice teams by involving professionals with specific behavioral and clinical expertise, for instance nurse case managers and health educators. Innovations in the organization of visits have made it easier for practice teams to conduct productive interactions. For many preventive services, the primary care provider initiates the intervention, but the actual procedure and more time-consuming activities are delivered in other settings by non-physician members of the health care team (Glasgow et al.). In Norway this may mean more emphasis on a multidisciplinary approach or introduction of financial incentives for more systematic provision of diabetes care. An incentive scheme whereby nurses and GPs receive extra refunds for reaching diabetes care-related targets could help improve foot examination rates.

The findings have significant implications for nurses in the community. Although nurses are in a good position to screen all patients with diabetes, activity is focused on providing treatment rather than on the prevention of ulcers or early detection. Screening results could be incorporated into a diabetic foot risk assessment system; patients could be trained in self-inspection of feet and patients at risk could be more closely followed up. Concordant with the chronic care model, these interests and behaviors could contribute to increasing the quality of care and enhancing the likelihood that optimal practice guidelines can be systematically followed in the future.

Data from the Diabetes Attitudes Wishes and Needs (DAWN) study (International DAWN Advisory Panel et al., 2006) showed that patient perceptions of diabetes care in Scandinavia included relatively low financial barriers to care and a relatively high level of perceived quality of provider team collaboration. People with more diabetes complications, however, felt that they had relatively poor access to providers. The DAWN study emphasized the importance of research comparing subjective and objective measure-

ments to support and validate these findings at national levels and the importance of translating national guidelines into practice. In keeping with this recommendation, a strength of our study is that the data from HUNT2 combined subjective indicators of the regularity of preventive foot care with objective measures of disease status (e.g., $HbA_{1c}$, insulin treatment, duration) within a population-based sample.

### Limitations

Limitations of the study include the fact that we were not able to evaluate whether group differences in the regularity of preventive diabetes foot care related to the quality of primary health care or to the completeness of reporting. Causal directions cannot be inferred from the cross-sectional data for which predictor and outcome variables were reported simultaneously. Another limitation is that the term *regular* was not predefined in the questionnaire. The lack of precision in the measure of the regularity of foot care was a limitation, however, all but one participant reported within the recommended interval of annual review in concordance with international and national guidelines. The intervals ranged from daily to yearly (range 1–55 weeks), with a median of 12 weeks. This means that the majority reported 3–4 months intervals.

Another limitation is that these data were self-reported and not cross-checked with medical records. Therefore the interpretation of the results needs some caution. In Norway the intervals between follow-ups may vary between type 1 and type 2 diabetes, with longer intervals for people with type 2 diabetes. However, the recommended intervals for follow-up in Norway are every 3rd or 4th month (Claudi et al., 1995, 2005), and the intervals reported by the respondents were consistent with these recommendations. In addition, the data from this population-based study did not provide clinically verified in-depth indicators of neuropathy or peripheral vascular disease, which would have allowed better identification of those with high-risk conditions. Working with data collected from 1995 to 1997 also is a limitation. However, the results are still relevant in present day practice, as national guidelines regarding foot care practices have not changed in the last 10 years (Claudi et al., 1995, 2005). Concordant with our findings, preliminary results from community-based cross-sectional studies carried out in Norway respectively in 1995 (Claudi et al., 2000), 2000, and 2006 (Claudi, personal communication), also have shown that foot care practices have not improved in these 10 years. In spite of these limitations, the findings offer a reasonable representation of the regularity of preventive foot care in Norway.

In order to assess the representativeness of these findings, respondents with diabetes who completed the diabetes questionnaire related to the regularity of preventive foot care were compared with respondents with diabetes who did not complete these questions. The results in the present study correspond with results from other studies in which non-responders tended to report more advanced disease than responders (Drivsholm et al., 2006). The estimated prevalence of the regularity of preventive diabetes foot care might therefore be underestimated. On the other hand, it is also possible that noncompletion of the diabetes questionnaire may be associated with lower use of the health care system, in which case the estimated prevalence is more likely to represent an overestimate. In any case, because the completion represented 74%, we consider the study estimates as representative for individuals with diabetes in our study population.

## CONCLUSIONS

Findings of the present study show that prevention of foot complications has not a sufficient focus in health care practices. Even in Norway, where the health care system carries the main financial burden of treating complications, there is a need for a more cogent, organized, and systematic approach to preventive foot care. The findings have significant implications for nurses and other members of the multidisciplinary team, suggesting that patients at risk be more closely followed up and aspects of preventive foot care systematically incorporated into national guidelines. Vulnerable groups include males, patients not using insulin, those with shorter diabetes duration, and those with macrovascular complications who may need more attention, with regular follow-ups and training in self-inspection of feet.

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