Determinants of Health Status Three to Six Years After Surgical Treatment of Closed Ankle Fracture and Comparison with the General Population

A Historical Cohort Study

Knut Stavem, MD, MPH, PhD, Markus G. Naumann, MD, Ulf Sigurdsen, MD, PhD, and Stein Erik Utvåg, MD, PhD

Investigation performed at Akershus University Hospital, Lørenskog, and Østfold Hospital, Grålum, Norway

Background: The purposes of the present study were to identify the determinants of health status 3 to 6 years after open reduction and internal fixation (ORIF) for the treatment of closed ankle fracture and to compare the health status of patients who had undergone this procedure with that in the general population after adjusting for sociodemographic variables, body mass index (BMI), and smoking status.

Methods: The present study was a historical cohort study combined with a postal survey. In total, 1,149 patients who underwent ORIF for the treatment of closed ankle fractures at 2 hospitals were eligible for chart review; 959 with low-energy fractures were eligible for a postal survey, and 471 (49%) responded to the Short Form Health Survey-36 (SF-36) health status questionnaire and provided data on BMI. Determinants of the physical functioning (PF), physical component summary (PCS), and mental component summary (MCS) scores of the SF-36 were analyzed by means of multivariable linear regression analysis. The health status of patients with an ankle fracture (n = 471) was compared with that in a sample of the general population (n = 5,396) by means of multivariable regression.

Results: Age, American Society of Anesthesiologists (ASA) class III, and complications following surgery were associated with PF and PCS scores, and a BMI of ≥30 kg/m² and current smoking status was associated with PF and MCS scores. However, the PF, PCS, and MCS scores of patients with ankle fractures did not differ from those of the general population, with unstandardized regression coefficients of 0.25 (95% confidence interval [CI], −1.67 to 2.16; p = 0.80), 0.67 (95% CI, −0.35 to 1.70; p = 0.199), and −0.57 (95% CI, −1.63 to 0.49; p = 0.29), respectively.

Conclusions: Age, ASA class III, and complications following surgery were associated with PF and PCS scores at 3 to 6 years after surgery for the treatment of closed ankle fractures. However, the health status of patients with ankle fractures did not differ from that in the general population after adjusting for differences in demographic variables, BMI, and smoking status.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

The importance of including the subjective experience of a patient when assessing the outcome of surgery for an ankle fracture—in addition to the judgment of the treating physician and radiographic results—has been acknowledged during the past decade. This assessment is typically carried out with use of measures of functional outcomes, health status, or health-related quality of life (HRQoL). Some authors consider health status to be merely an assessment of functioning, whereas HRQoL focuses on a subjective evaluation of well-being; numerous authors use these terms
interchangeably. Health status is associated with age and sex, for example, as assessed with the Short Form Health Survey-36 (SF-36) questionnaire. Therefore, normative data for general populations are collected to aid the interpretation of health status scores.

There have been few reliable studies of health status following ankle fractures, and most studies have been small and have included inconsistent sociodemographic and clinical factors. Female sex, a low education level, and alcohol consumption have been associated with impaired health status after ankle fracture, whereas the associations of fracture type and smoking status with health status or functional outcome have been inconclusive.

The purposes of the present study were (1) to identify the determinants health status 3 to 6 years after open reduction and internal fixation (ORIF) for the treatment of closed ankle fracture and (2) to compare the health status of patients who had undergone this procedure with that in the general population after adjusting for sociodemographic variables, body mass index (BMI), and smoking status.

Materials and Methods

Ankle-Fracture Cohort

The present historical cohort study involved all patients with an age of ≥18 years who were managed with ORIF for the treatment of an unstable and closed ankle fracture between January 1, 2009, and December 31, 2011, at 2 Norwegian hospitals: Østfold Hospital and Akershus University Hospital. The combined geographical catchment area of these hospitals has about 730,000 inhabitants.

Patients were selected from the information systems of the hospitals on the basis of discharge diagnoses (codes S82.3 to S82.9, S93.2, and S93.4 in the 10th revision of the International Classification of Diseases) combined with surgical procedure codes (NHJ00 to NHJ98 and NHE 99 in the Nordic Medico-Statistical Committee Classification of Surgical Procedures).

In total, 1,149 patients were eligible for chart review. We excluded 138 of these patients for various reasons: living outside the hospitals’ catchment areas, misclassification of the fracture or the year of the fracture, polytrauma, high-energy trauma (motor-vehicle or motorcycle accidents, bicycle accidents, skiing accidents, pedestrian-motor-vehicle accidents, and falls from a height of ≥3 m), conservative treatment, previous fracture in the same limb, cognitive problems, or appendicitis/intoxication. Before the postal survey in January 2015, we excluded another 52 patients who had died or moved out of the area (Fig. 1). Hence, the questionnaire was mailed to 959 patients. A reminder was sent 4 weeks later to the nonrespondents. Overall, 549 patients (57%) responded; of these, 471 (49% of 959) completed the SF-36 questionnaire, provided data on BMI, and had a baseline BMI of ≥18.5 kg/m² and were included in the analyses.

The study was approved by the Norwegian Social Science Data Services (approval no. 28813/5) and the Regional Committee for Medical and Health Research Ethics, Health Region South East (approval no. 2012/384).

Chart Review and Variables

The electronic chart and radiographs for each patient were reviewed by 1 of the authors (M.G.N. or U.S.) to verify diagnoses and procedures and to collect information including age at the time of injury, sex, BMI (in kg/m²), physical status before surgery (American Society of Anesthesiologists [ASA] classes I to III [I, completely healthy and fit; II, mild systemic disease; or III, severe systemic disease]), diabetes, current smoking status, fracture classification, and duration of surgery (in minutes).

Fracture Classification and Treatment

The radiographs were classified with use of the Weber system and as unimalleolar, bimalleolar, or trimalleolar fractures. All patients had surgery with ORIF in accordance with recommendations from the Arbeitsgemeinschaft für Osteosynthesefragen and others. All procedures were carried out by consultants or residents with experience in operative ankle fixation. Syndesmotic injuries usually were treated with a 3.5-mm 4-cortex screw, which was removed 8 to 12 weeks after surgery.

Complications

We analyzed the available data for the occurrence of complications, including venous thrombosis or pulmonary embolism (within 3 months); infection or reoperation because of wound problems, decubitus ulcer, or compartment syndrome (within 6 months); malunion, arthrosis, screw removal (except planned removal of a syndesmosis screw), reoperation because of malfixation, reconstruction because of a missed syndesmotic fracture, failed syndesmotic fixation, redislocation, or pseudarthrosis (within 12 months); and reoperation because of arthritis, pain, stiffness, or the removal of osteosynthesis material (within 24 months). A maximum of 3 complications were recorded per patient. If more than 3 complications were reported, those considered the most severe were recorded.

General-Population Sample

Study Design and Variables

Responses on the Norwegian SF-36 (version 1.2) for the general population were collected by Statistics Norway in 2002. That survey involved 9,698 members of the general population with an age of ≥16 years who were representative of the entire Norwegian population. Home or telephone interviews were performed prior to the postal survey. After the exclusion of 23 subjects who resided outside of Norway, who were confined to an institution, or who had died and 511 additional subjects who had language difficulties, who were unable to complete the questionnaire because of illness or handicap, or who declined to participate, 9,164 subjects were sent a questionnaire between November 15, 2002, and May 15, 2003. Responses were received from 6,193 subjects (68%), 5,396 of whom had also completed an interview and 5,173 of whom (comprising 56% of those who had received...
the questionnaire) had completed both an interview and the SF-36.

In the general-population survey, daily current smoking was captured by combining 2 items (i.e., "Do you ever smoke?" and "Do you smoke daily or sometimes?"). BMI was calculated from the self-reported height and weight.

Assessment of Health Status
Health status was assessed with use of the SF-36, a generic 36-item questionnaire with documented reliability and validity, which has been recommended and used for assessing the outcome of ankle surgery.

The SF-36 assesses 8 dimensions of health on a scale from 0 (minimum) to 100 (maximum): physical functioning (PF), role limitations-physical, bodily pain, general health perception, vitality, social functioning, role limitations-emotional, and mental health. The 8 scales can be aggregated into 2 summary scales: the physical component summary (PCS) and the mental component summary (MCS). In the present study, the Norwegian standard SF-36 (version 1.2) was used. We assessed determinants of the PCS, MCS, and PF scales of the SF-36, which we expected a priori to be the most sensitive to the effects of ankle surgery.

Statistical Analysis
Descriptive statistics are presented as the mean and standard deviation (SD), the median and interquartile range, or the number and percentage, as appropriate. Groups were compared with use of the t test, the Mann-Whitney U test, or the Fisher exact test, as appropriate.

We analyzed the determinants of health status, selecting variables on the basis of our own prior knowledge and the available data, and all of these variables were included in models for the determination of the PF, PCS, and MCS within the ankle-fracture cohort. We included the independent variables of age (continuous), sex, highest attained education
level (7 to 10 years, 11 to 13 years, or >13 years/university),
current smoking status (yes or no, with exclusion of subjects
for whom the smoking status was unknown), and BMI (18.5
to 24.9, 25.0 to 29.9, or ≥30.0 kg/m²), diabetes (yes or no),
ASA class (I, II, or III), duration of surgery (per 15 minutes),
and any complication following surgery (yes or no). We did
not impute missing values prior to the analysis.

In a supplementary analysis, we assessed the impact of 4
complications. These complications were entered as 4 dummy
variables into the same multivariable model as above, replacing
the 1 variable for aggregate complications.

We compared the health status between the ankle-
fracture cohort and the general population with use of multi-
variable linear regression analysis while adjusting for age, sex,
education level, BMI, and current smoking status, with use of
the classifications listed above.

Some of the residuals in the linear regression models did
not conform to a normal distribution. Log-transformation or
square-root transformation of the affected dependent variables
did not materially improve this situation. Therefore, we used
the untransformed values for the dependent variables but used
bootstrapped 95% confidence intervals (CIs) with 500 repli-
cations in all models.

We chose a significance cutoff of p < 0.05 in 2-sided tests.
All statistical analyses were conducted with use of Stata soft-
ware (version 14.1).

### TABLE 1 Descriptive Statistics and Comparisons Between Survey Respondents and Nonrespondents/Exclusions

|                          | Respondents (N = 471) | Value       | Nonrespondents/Exclusions (N = 488) | Value       | P Value     |
|--------------------------|-----------------------|-------------|-------------------------------------|-------------|------------|
| Age at surgery* (yr)     | 52.5 ± 14.7           |             | 48.3 ± 17.6                         |             | <0.001     |
| Female sex (no. of patients) | 270 (57%)           |             | 235 (48%)                           |             | 0.092      |
| Education (no. of patients) | 459                        | 85          |                                    |             | 0.087      |
| <11 yr                   | 124 (27%)             |             | 33 (39%)                            |             |            |
| 11 to 13 yr              | 178 (39%)             |             | 28 (33%)                            |             |            |
| >13 yr/university        | 157 (34%)             |             | 24 (28%)                            |             |            |
| BMI* (kg/m²)             | 27.8 ± 4.9            |             | 27.5 ± 5.3                          |             | 0.40       |
| Current smoker (no. of patients) | 116 (26%)          |             | 167 (36%)                           |             | 0.001      |
| ASA class (no. of patients) | 471                        | 488          |                                    |             | 0.60       |
| I. Normal/healthy patient | 162 (34%)            |             | 170 (35%)                           |             |            |
| II. Mild systemic disease | 284 (60%)            |             | 285 (58%)                           |             |            |
| III. Severe systemic disease | 25 (5%)            |             | 33 (7%)                             |             |            |
| Diabetes (no. of patients) | 28 (6%)               |             | 20 (4%)                             |             |            |
| Unimalleolar, bimalleolar, trimalleolar fracture (no. of patients) | 240 (52%)          |             | 269 (56%)                           |             |            |
| Corticosteroid use (no. of patients) | 22 (5%)            |             | 19 (4%)                             |             |            |
| Duration of surgery† (min) | 78 (55 to 108)      |             | 75 (55 to 100)                      |             | 0.152      |
| Operated on within 8 hr (no. of patients) | 164 (35%)          |             | 130 (27%)                           |             | 0.006      |
| Hospital (no. of patients) | 205 (44%)            |             | 262 (54%)                           |             | 0.002      |
| Akershus University Hospital | 266 (56%)           |             | 226 (46%)                           |             |            |
| Østfold Hospital         | 118 (25%)             |             | 87 (18%)                            |             | 0.007      |
| Removal of osteosynthesis material (no. of patients) | 66 (14%)           |             | 43 (9%)                             |             | 0.014      |
| Infection, superficial or deep (no. of patients) | 30 (6%)             |             | 23 (5%)                             |             | 0.32       |
| Malfixation/pseudarthrosis (no. of patients) | 15 (3%)             |             | 14 (3%)                             |             | 0.85       |
| Venous thromboembolism (no. of patients) | 8 (2%)              |             | 6 (1%)                              |             | 0.60       |

*The values are given as the mean and the standard deviation. †The values are given as the median, with the 25th to 75th percentiles in parentheses.
Results

Samples and Respondents

In total, 471 (49%) of the 959 subjects with an ankle fracture had a baseline BMI of ≥18.5 kg/m² and responded to the SF-36 questionnaire at a median of 4.3 years (range, 3.1 to 6.2 years) after surgery. These 471 respondents were older, were less likely to be current smokers at the time of the injury, were more likely to have undergone surgery within 8 hours after the injury, were more likely to be recruited from the Østfold hospital, and were more likely to have had a complication than the 488 who were nonrespondents or were excluded (Table I).

The patients with an ankle fracture were older, had a larger proportion of women, had a different distribution in length of education (with a larger proportion with <11 years and >13 years of education), and had a higher BMI than did the

| TABLE II Descriptive Statistics for the 2 Populations at the Time of the Surveys |
|----------------------------------|-------------------------------|-----------------|-----------------|--------------------|
|                                  | Ankle-Fracture Cohort         | General Population Sample |
|                                  | N    | Value            | N          | Value            | P Value |
| Age* (yr)                        | 471  | 56.9 ± 14.7      | 5,173     | 46.4 ± 17.2      | <0.001  |
| Female sex (no. of patients)     | 471  | 270 (57%)        | 5,173     | 2,611 (50%)      | 0.005   |
| Education (no. of patients)      | 459  | 124 (27%)        | 770       | 15%              | <0.001  |
| <11 yr                           |      | 124 (27%)        | 770       | 15%              | <0.001  |
| 11 to 13 yr                      |      | 178 (39%)        | 2,811     | (56%)            |         |
| >13 yr/university                |      | 157 (34%)        | 1,467     | (29%)            |         |
| BMI* (kg/m²)                     | 471  | 27.8 ± 4.9       | 5,173     | 24.9 ± 3.6       | <0.001  |
| Current smoker (no. of patients) | 453  | 116 (26%)        | 5,172     | 1,295 (25%)      | 0.81    |

*The values are given as the mean and the standard deviation.

| TABLE III Determinants of SF-36 Dimension Scores on Multivariable Linear Regression Analysis |
|--------------------------------------------------------------------------------------------|
|                                                                                               |
| Physical Functioning (N = 435)                                                               |
|                                                                                               |
| Coefficient*  P Value                                                                       |
| Age, per 10 years                                                                           |
| -2.89 (-4.51 to -1.27)                                                                      |
| <0.001                                                                                      |
| Male sex                                                                                    |
| 2.93 (-1.23 to 7.08)                                                                         |
| 0.167                                                                                       |
| Education                                                                                   |
| 11 to 13 yr                                                                                 |
| 5.20 (-0.22 to 10.61)                                                                       |
| 0.060                                                                                       |
| >13 yr/university                                                                           |
| 7.89 (2.74 to 13.01)                                                                         |
| 0.003                                                                                       |
| BMI                                                                                         |
| Overweight (BMI = 25.0 to 29.9 kg/m²)                                                        |
| 0.29 (-4.05 to 4.63)                                                                         |
| 0.90                                                                                         |
| Obesity (BMI ≥30.0 kg/m²)                                                                    |
| -6.40 (-11.45 to -1.34)                                                                     |
| 0.013                                                                                       |
| ASA class                                                                                   |
| II. Mild systemic disease                                                                    |
| -3.47 (-7.47 to 0.52)                                                                       |
| 0.089                                                                                       |
| III. Severe systemic disease                                                                |
| -16.51 (-28.02 to -5.01)                                                                    |
| 0.005                                                                                       |
| Diabetes                                                                                    |
| -2.36 (-11.21 to 6.50)                                                                       |
| 0.60                                                                                         |
| Current smoker                                                                             |
| -5.44 (-10.47 to -0.41)                                                                     |
| 0.034                                                                                       |
| Unimalleolar, bimalleolar, trimalleolar fracture                                              |
| Bimalleolar                                                                                 |
| -3.86 (-9.15 to 1.43)                                                                       |
| 0.153                                                                                       |
| Trimalleolar                                                                                |
| -4.22 (-10.57 to 2.12)                                                                       |
| 0.192                                                                                       |
| Duration of surgery, per 15 minutes                                                         |
| -0.80 (-1.69 to 0.08)                                                                       |
| 0.074                                                                                       |
| Any complication                                                                           |
| -8.59 (-13.46 to -3.72)                                                                      |
| 0.001                                                                                       |

*Unstandardized regression coefficient. The 95% CI is given in parentheses.
general population sample, but there was no difference between the groups in terms of smoking status (Table II).

**Determinants of Health Status**

Multivariable regression analysis with the PF score as the dependent variable demonstrated that an increase of 10 years in age, a BMI of ≥30 kg/m², ASA class III, current smoking status, and having experienced complications following surgery were associated with lower health status and that a higher education level was associated with higher health status (Table III). The presence of bimalleolar and trimalleolar fractures exerted a smaller effect than did many of the demographic variables, and the effects were statistically nonsignificant for all 3 scales.

When the PCS was used as the dependent variable, the pattern was similar, but with somewhat lower effects for most variables, with the exception that education level and current smoking were not associated with health status while ASA class II was associated with health status.

The unstandardized regression coefficients of the independent variables with the MCS score were smaller, and only a BMI of ≥30.0 kg/m² and current smoking were significantly associated with a worse health status. Variables that were more closely related to the actual fracture, such as fracture class, duration of surgery, and complications, were not associated with the MCS (Table III).

Removal of osteosynthesis material was associated with reduced health status; however, infectious complications, malfixation, and venous thromboembolism were not (Table IV).

**Comparison of Health Status with the General Population**

After adjusting for age, sex, BMI, education level, and current smoking, the health status on the PF, PCS, or MCS scale did not differ between the ankle cohort and the general population.

### TABLE IV SF-36 Scores According to Postoperative Complications on Multivariable Linear Regression Analysis*

|                     | Physical Functioning (N = 435) | Physical Component Summary (N = 406) | Mental Component Summary (N = 406) |
|---------------------|--------------------------------|-------------------------------------|-----------------------------------|
|                     | Coefficient† | P Value  | Coefficient† | P Value  | Coefficient† | P Value  |
| Removal of osteosynthesis material | −6.75 (−12.71 to −0.79) | 0.026  | −3.00 (−5.94 to −0.06) | 0.045  | −1.54 (−4.89 to 1.80) | 0.37  |
| Infection, deep or superficial | −3.29 (−10.07 to 3.49) | 0.34  | −1.55 (−4.69 to 1.59) | 0.33  | −0.30 (−4.51 to 3.91) | 0.89  |
| Malfixation/pseudarthrosis | −5.30 (−19.56 to 8.96) | 0.47  | −2.40 (−9.33 to 4.53) | 0.50  | 0.30 (−4.17 to 4.76) | 0.90  |
| Venous thromboembolism | −5.00 (−26.11 to 16.10) | 0.64  | 0.53 (−7.78 to 8.84) | 0.90  | 0.49 (−5.19 to 6.17) | 0.87  |

*Adjusted for age, sex, education, BMI, ASA class, diabetes, smoking status, fracture class (unimalleolar/bimalleolar/trimalleolar), and duration of surgery. †Unstandardized regression coefficient. The 95% CI is given in parentheses.

### TABLE V Comparison of SF-36 Scores Between Ankle Cohort and General Population on Multivariable Linear Regression Analysis

|                     | Physical Functioning (N = 5,488) | Physical Component Summary (N = 5,280) | Mental Component Summary (N = 5,280) |
|---------------------|---------------------------------|--------------------------------------|-------------------------------------|
|                     | Coefficient* | P Value  | Coefficient* | P Value  | Coefficient* | P Value  |
| Ankle fracture      | 0.25 (−1.67 to 2.16) | 0.80  | 0.67 (−0.35 to 1.70) | 0.199  | −0.57 (−1.63 to 0.49) | 0.29  |
| Age, per increase of 1 yr | −0.46 (−0.50 to −0.43) | <0.001  | −0.21 (−0.22 to −0.19) | <0.001  | 0.06 (0.05 to 0.08) | <0.001  |
| Female sex          | −4.47 (−5.45 to −3.49) | <0.001  | −1.94 (−2.45 to −1.44) | <0.001  | −1.15 (−1.63 to −0.67) | <0.001  |
| BMI                 | −1.69 (−2.77 to −0.60) | 0.002  | −1.03 (−1.58 to −0.49) | <0.001  | −0.31 (−0.86 to 0.23) | 0.26  |
| Overweight (BMI = 25.0 to 29.9 kg/m²) | −9.09 (−10.99 to −7.20) | <0.001  | −4.54 (−5.46 to −3.62) | <0.001  | −1.35 (−2.39 to −0.31) | 0.011  |
| Obesity (BMI ≥30.0 kg/m²) | −1.77 (−3.02 to −0.78) | 0.001  | −1.03 (−1.63 to −0.43) | 0.001  | −1.77 (−2.41 to −1.12) | <0.001  |
| Education           | 11 to 13 yr | 7.01 (5.32 to 8.69) | <0.001  | 2.33 (1.45 to 3.21) | <0.001  | 1.58 (0.72 to 2.44) | <0.001  |
|                     | >13 yr | 11.53 (9.83 to 13.23) | <0.001  | 4.40 (3.55 to 5.24) | <0.001  | 2.01 (1.12 to 2.89) | <0.001  |

*Unstandardized regression coefficient. The 95% CI is given in parentheses.
The present study demonstrated that higher age, ASA class III, and complications following surgery were associated with lower PF and PCS scores, and a BMI of $\geq 30$ kg/m$^2$ and current smoking were associated with lower PF and MCS scores at 3 to 6 years after ORIF for the treatment of ankle fracture. Removal of osteosynthesis material was associated with lower PF and PCS scores, but the presence of bimalleolar or trimalleolar fractures was not. The fracture-related variables were not associated with a worse MCS score. Moreover, the health status of the patients 3 to 6 years after surgery was comparable with that in the general population after adjusting for differences in demographic variables, BMI, and smoking status.

The associations of higher age, ASA class III, and complications following surgery with lower PF or PCS scores and of a BMI of $\geq 30$ kg/m$^2$ and current smoking status with lower PF scores support the findings at 1 to 2 years after ankle surgery in smaller studies. For example, female sex, a low education level, and alcohol consumption were previously found to be associated with impaired health status after ankle fracture, whereas the associations of fracture type and smoking status with health status and functional outcome were inconclusive. In contrast, Anderson et al., in a study involving 33 patients, found that the SF-36 and Olerud and Molander scores were comparable at 2 years after ankle-fracture surgery among patients $\geq 65$ and $\leq 65$ years of age, with the exception that the MCS scores were higher in the former group; however, that analysis did not adjust for other differences between the groups.

The finding that patients with removed metal implants had lower health status at 3 to 6 years after surgery than others did should be interpreted with caution. There is a possibility of selection bias, and we had no information on health status before surgery. The finding that there was no difference in health status among patients with unimalleolar, bimalleolar, and trimalleolar fractures supports previous findings obtained with use of the SF-36 and with functional outcomes determined according to fracture severity with use of different classification systems. However, this finding contrasts with a previous report of outcomes being worse for patients with bimalleolar fractures than for those with unimalleolar fractures.

The association of a higher BMI with a worse PF score is consistent with previous studies that have applied the SF-36 instrument in other populations. Previous studies comparing the health status after ankle fracture with population norms have been heterogeneous with regard to study size and designs, follow-up times, analytic methods, and findings. One study demonstrated no impairment in health status compared with norms at 1.5 years after ankle surgery, another demonstrated comparable results after 2 years except for those on the PF and role-physical scales, and 2 other studies demonstrated a worse health status at 2 to 5 years after surgery. In the study by Nilsson et al., PF scores at 6 months after surgically treated ankle fractures in Swedish women $>65$ years of age were lower than age and gender-matched population reference values. In the same study, there was no difference in PF scores between the groups at 12 months after surgery. Moreover, there was no difference in PF scores among men $>65$ years of age and population reference values at 6 or 12 months after ankle surgery.

All of those previous studies involved the use of published norms for comparisons, most often adjusting for age and sex. In contrast, the present study compared health status following ankle surgery with that in a large general-population sample directly while adjusting for age, sex, highest attained education level, and BMI, all of which are known to influence health status. Finally, another study demonstrated that SF-36 scores differed between patients with ankle fractures and controls on the 8 subscales, the PCS, and the MCS, but they did not differ among patients with unimalleolar, bimalleolar, or trimalleolar fractures on any of the scales. The controls were matched with the cases for age, sex, and BMI, although the matching procedure was not described, and the proportion of women differed between the groups. The authors of studies on acute hospital care can rarely access data on preinjury assessments of health status, which are required for the assessment of change in health status. For health-status measures such as the SF-36, norms for the general population are often available for cross-sectional comparison, in contrast to most functional outcomes, for which such population norms are unavailable.

The present study was larger than previous studies, had a longer time span from surgery to follow-up than most previous studies, and compared SF-36 scores with the population norms directly while also adjusting for education level and BMI in addition to age and sex, which normally are the only characteristics available for normative populations.

The limitations of the present study include its retrospective design and the use of chart review for data collection, which limited the number, quality, and completeness of variables that could be collected. For example, some potentially relevant variables, such as the functional status before surgery, detailed information on comorbidity, and reliable data on alcohol use, were not available. We had no standardized protocol to assess the quality of the reduction, which may have influenced the results. Moreover, the chart and radiograph reviews for each patient were performed by a single researcher; therefore, the interrater reliability and validity for the data extracted were not assessed. In the chart review, we registered a maximum of 3 complications. As no patient had $>3$ complications, the cap on the maximum number of registered complications did not limit the number of low-grade complications reported. Only 57% of patients responded to the questionnaires, and 49% of those who were mailed the questionnaires had available BMI and responded to the PF scale of the SF-36, which may seem to be low percentages. However, we believe that this response rate is acceptable, given that the survey was...
conducte 3 to 6 years after surgery, the patients had finished their contact with the hospital, and most of the patients were expected to do well.

In the ankle-surgery cohort, the height and weight assessments as well as the information on smoking status were based on data from the medical records obtained at the time of surgery. Hence, there was a delay of 3 to 6 years between the date of this information and the completion of the questionnaire, and the BMI and smoking status may have changed during this time period. Moreover, the patients may have experienced other health changes or events during this period.

The lack of association of ankle-fracture surgery with health status after adjusting for sociodemographic variables and BMI in the pooled samples suggests that the benefit from ankle surgery is similar for obese patients (BMI ≥30 kg/m²) and non-obese patients.

In conclusion, the present study demonstrated that higher age, ASA class III, and having experienced complications following surgery were associated with lower PF and PCS scores and a BMI of ≥30 kg/m² and current smoking status were associated with lower PF and MCS scores 3 to 6 years after ORIF for closed ankle fractures. The health status of patients after surgery was consistent with that in the general population.

References

1. Kitaoka HB, Alexander U, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994 Jul;15(7):349-53.
2. Øbremskyme WT, Dirschl DR, Crowther JD, Craig WL 3rd, Driver RE, LeCroy CM. Change over time of SF-36 functional outcomes for operatively treated unstable ankle fractures. J Orthop Trauma. 2002 Jan;16(1):303.
3. Øbremskyme WT, Brown O, Driver R, Dirschl DR. Comparison of SF-36 and Short Musculoskeletal Functional Assessment in recovery from fixation of unstable ankle fractures. Orthopedics. 2007 Feb;30(2):145-51.
4. Van Son MA, De Vries J, Oudsten BL. Health status, health-related quality of life, and quality of life following ankle fractures: a systematic review. Injury. 2013 Nov;44(11):1391-402. Epub 2013 Mar 13.
5. Ware JE Jr, Kosinski M, Keller SD. SF-36 physical and mental health summary scales: a user’s manual. Boston: The Health Institute, New England Medical Center; 1994.
6. Jenkinson C, Coulter A, Wright L. Short Form 36 (SF36) health survey questionnaire: normative data for adults of working age. BMJ. 1993 May 29;306(6890):1437-40.
7. Garratt AM, Stavem K. Measurement properties and normative data for the Norwegian SF-36: results from a general population survey. Health Qual Life Outcomes. 2017 Mar 14;15(1):51.
8. Bhandari M, Sprague S, Hanson B, Busse JW, Dawe DE, Moro JK, Guyatt GH. Health-related quality of life following operative treatment of unstable ankle fractures: a prospective observational study. J Orthop Trauma. 2004 Jul;18(6):338-45.
9. Nilsson G, Jonsson K, Ekdahl C, Eneroth M. Outcome and quality of life after surgically treated ankle fractures in patients 65 years or older. BMC Musculoskelet Disord. 2007 Dec 20;8:127.
10. Egoi AL, Tejwani NC, Walsh MG, Capila EL, Koval KJ. Predictors of short-term functional outcome following ankle fracture surgery. J Bone Joint Surg Am. 2006 May;88(5):974-9.
11. Naumann MG, Sigurdsen U, Utvåg SE, Stavem K. Incidence and risk factors for removal of an internal fixation following surgery for ankle fracture: a retrospective cohort study of 997 patients. Injury. 2016 Aug;47(8):1783-8. Epub 2016 Jun 1.
12. World Health Organization. International statistical classification of diseases and related health problems 10th revision. 2010. http://apps.who.int/classifications/icd10/browse/2010/en. Accessed 2017 Jun 21.
13. Nordic Medico-Statistical Committee (NOMESCO). NOMESCO classification of surgical procedures (NCSNP), version 1.16. 2011. http://www.nordicclass.se/NCSNP_1.16.pdf. Accessed 2017 Jun 21.
14. American Society of Anesthesiologists. ASA physical status classification system. 2014. http://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system. Accessed 2017 Jun 21.
15. Weber BG. Die Verletzungen des oberen Sprunggelenkes. Bern: Hans Huber; 1966.
16. Rockwood CA, Green DP, Bucholtz RW, Rockwood & Green’s fractures in adults. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010.
17. Naumann MG, Sigurdsen U, Utvåg SE, Stavem K. Associations of timing of surgery with postoperative length of stay, complications, and functional outcomes 3-6 years after operative fixation of closed ankle fractures. Injury. 2017 Mar;51:13-18. Epub 2017 Mar 13.
18. Hougen H, Giaborden MH. Samordnet levesnurserundersøkelse 2002- tverrsnittsundersøkelser. Dokumentasjonsrapport. Oslo: Statistics Norway; 2004.
19. Loge JH, Kaasa S, Hjemstad MJ, Kvien TK. Translation and performance of the Norwegian SF-36 Health Survey in patients with rheumatoid arthritis. I. Data quality, scaling assumptions, reliability, and construct validity. J Clin Epidemiol. 1998 Nov;51(11):1069-76.
20. McHorney CA, Ware JE Jr, Lu JF, Sherbourne CD. The MOS 36-item Short-Form Health Survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. Med Care. 1994 Jan;32(1):40-66.
21. Ruta DA, Abdalla MI, Garratt AM, Coutts A, Russell IT. SF 36 health survey questionnaire: I. Reliability in two patient based studies. Qual Health Care. 1994 Jan;3(4):180-5.
22. Porzner S, Næsell H, Bergman B, Tønkvist H. Functional outcome and quality of life in patients with Type B ankle fractures: a two-year follow-up study. J Orthop Trauma. 1999 Jun;13(5):363-8.
23. Anderson SA, Li X, Franklin P, Wixted JJ. Ankle fractures in the elderly: initial and long-term outcomes. Foot Ankle Int. 2008 Dec;29(12):1184-8.
24. Tejwani NC, Paih B, Egoi KA. Effect of posterior malleous fracture on outcome after unstable ankle fracture. J Trauma. 2010 Sep;69(3):666-9.
25. Wikerøy AK, Helness PR, Andreassen GS, Hellund JC, Madsen JE. No difference in functional and radiographic results 8.4 years after quadriclefical compared with tricortical syndesmosis fixation in ankle fractures. J Orthop Trauma. 2010 Jan;24(1):17-23.
26. Loge JH, Kaasa S, Short Form 36 (SF-36) health survey: normative data from the general Norwegian population. Scand J Soc Med. 1998 Dec;26(4):250-8.
27. Segal G, Elbaz A, Pansal A, Heller Z, Palmanovich E, Nyska M, Feldbrin Z, Kish B. Clinical outcomes following ankle fracture: a cross-sectional observational study. J Foot Ankle Res. 2014 Nov 28;7(1):50.
28. Broos PL, Bisschop AP. Operative treatment of ankle fractures in adults: correlation between types of fracture and final results. Injury. 1991 Sep;22(5):403-6.
29. Hancock MJ, Herbert RD, Stewart M. Prediction of outcome after ankle fracture. J Orthop Sports Phys Ther. 2005 Dec;35(12):786-92.
30. Tejwani NC, McLaurin TM, Walsh M, Bhdasvai S, Koval J, Egoi KA. Are outcomes of bimalleolar fractures poorer than those of lateral malleolar fractures with medial ligamentous injury? J Bone Joint Surg Am. 2007 Jul;89(7):1438-41.
31. Huang IC, Franjakis C, Wu AW. The relationship of excess body weight and health-related quality of life: evidence from a population study in Taiwan. Int J Obes. 2006 Aug;30(8):1250-9. Epub 2006 Mar 7.
32. Kortt MA, Clarke PM. Estimating utility values for health states of overweight and obese individuals using the SF-36. Qual Life Res. 2005 Dec;14(10):2177-85.
33. Kortt MA, Dollery B. Association between body mass index and health-related quality of life among an Australian sample. Clin Ther. 2011 Oct;33(10):1466-74. Epub 2011 Sep 15.
34. Vasiljevic N, Ralevic S, Marinkovic J, Kocev N, Maksimovic M, Milosevic GS, Tomic J. The assessment of health-related quality of life in relation to the body mass index value in the urban population of Belgrade. Health Qual Life Outcomes. 2008 Nov 29;6:106.
35. Zhu Y, Wang Q, Pang G, Lin L, Origasa H, Wang Y, Di J, Shi M, Fan C, Shi H. Association between body mass index and health-related quality of life: the "obesity paradox" in 21,218 adults of the Chinese general population. PLoS One. 2015 Jun 18;10(6):e0130613.
36. Weening B, Bhandari M. Predictors of functional outcome following transsyndesmotic screw fixation of ankle fractures. J Orthop Trauma. 2005 Feb;19(2):102-8.
37. Obremskey WT, Dart B, Medina M. Rate of return of functional outcome after open reduction and internal fixation of unstable ankle fractures. Am J Orthop. 2009 May;38(5):227-31.
38. Lash N, Horne G, Fielden J, Devane P. Ankle fractures: functional and lifestyle outcomes at 2 years. ANZ J Surg. 2002 Oct;72(10):724-30.