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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

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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/m^2 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[1-3]. 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[4]; numerous authors use these terms

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interchangeably. Health status is associated with age and sex, for example, as assessed with the Short Form Health Survey-36 (SF-36) questionnaire[5,6]. Therefore, normative data for general populations are collected to aid the interpretation of health status scores[5-7].

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[4]. Female sex, a low education level, and alcohol consumption have been associated with impaired health status after ankle fracture[8,9], whereas the associations of fracture type and smoking status with health status or functional outcome have been inconclusive[8,10].

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

Subjects and Study Design

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[11].

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)[12] combined with surgical procedure codes (NHJ00 to NHJ98 and NHE 99 in the Nordic Medico-Statistical Committee Classification of Surgical Procedures)[13].

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 apoplexia/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/m^2 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/m^2), 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])[14], 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[15] and as unimalleolar, bimalleolar, or trimalleolar fractures. All patients had surgery with ORIF in accordance with recommendations from the Arbeitsgemeinschaft für Osteosynthesefragen and others[16]. All procedures were carried out by consultants or residents with experience in operative ankle fixation[17]. 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[18]. 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[19]. 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

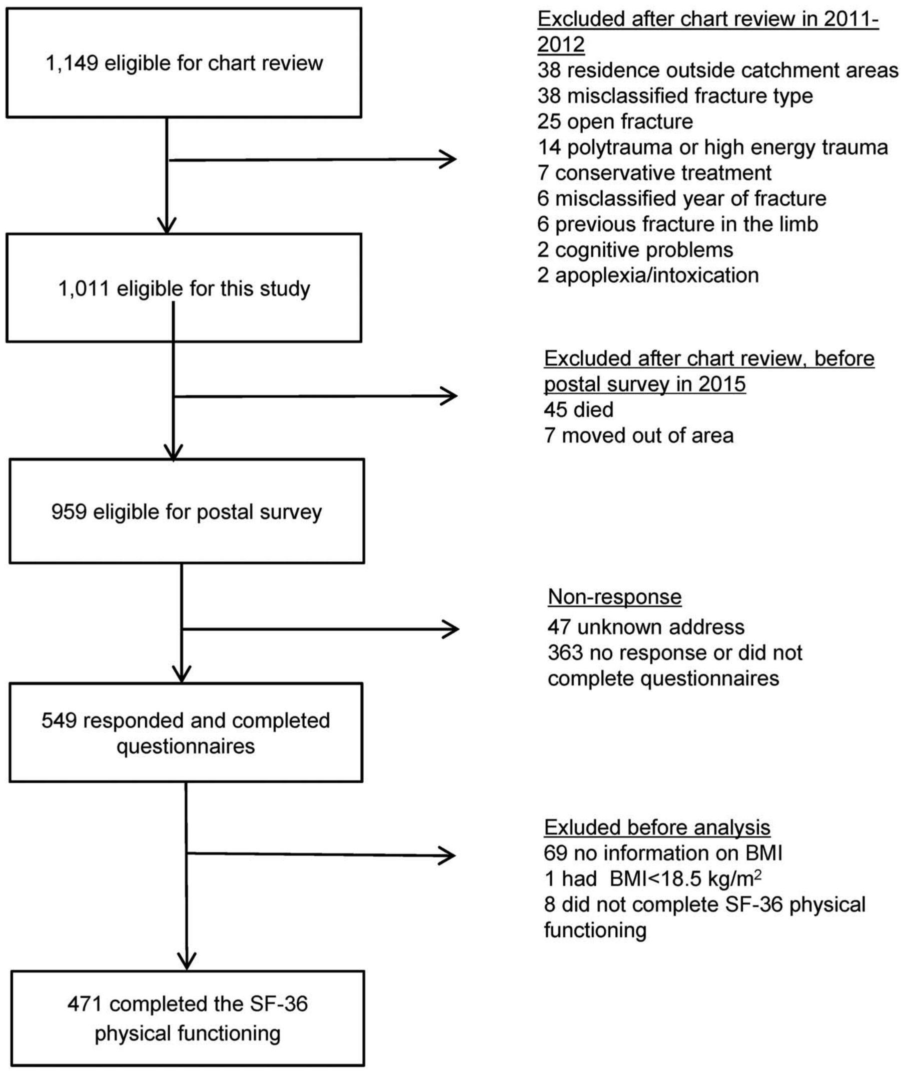

Fig. 1

Patient recruitment and attrition in the ankle surgery study.

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[20,21], which has been recommended and used for assessing the outcome of ankle surgery[2,8,9,22-25].

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)[5]. In the present study, the Norwegian standard SF-36 (version 1.2) was used[7,26]. 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[8,9].

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

TABLE I Descriptive Statistics and Comparisons Between Survey Respondents and Nonrespondents/Exclusions

	Respondents		Nonrespondents/Exclusions		
	N	Value	N	Value	P Value
Age at surgery* *(yr)*	471	52.5 ± 14.7	488	48.3 ± 17.6	<0.001
Female sex *(no. of patients)*	471	270 (57%)	488	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)*	471	27.8 ± 4.9	376	27.5 ± 5.3	0.40
Current smoker *(no. of patients)*	453	116 (26%)	463	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)*	471	28 (6%)	488	20 (4%)	
Unimalleolar, bimalleolar, trimalleolar fracture *(no. of patients)*	465		480		0.38
Unimalleolar		240 (52%)		269 (56%)	
Bimalleolar		112 (24%)		107 (22%)	
Trimalleolar		113 (24%)		104 (22%)	
Corticosteroid use *(no. of patients)*	471	22 (5%)	487	19 (4%)	
Duration of surgery† *(min)*	471	78 (55 to 108)	486	75 (55 to 100)	0.152
Operated on within 8 hr *(no. of patients)*	471	164 (35%)	488	130 (27%)	0.006
Hospital *(no. of patients)*	471		488		0.002
Akershus University Hospital		205 (44%)		262 (54%)	
Østfold Hospital		266 (56%)		226 (46%)	
Any complication *(no. of patients)*	471	118 (25%)	488	87 (18%)	0.007
Removal of osteosynthesis material *(no. of patients)*	471	66 (14%)	488	43 (9%)	0.014
Infection, superficial or deep *(no. of patients)*	471	30 (6%)	488	23 (5%)	0.32
Malfixation/pseudarthrosis *(no. of patients)*	471	15 (3%)	488	14 (3%)	0.85
Venous thromboembolism *(no. of patients)*	471	8 (2%)	488	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.

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 multivariable 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 replications 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 software (version 14.1).

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		5,048		<0.001
<11 yr		124 (27%)		770 (15%)	
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.

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 III Determinants of SF-36 Dimension Scores 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
Age, per 10 years	−2.89 (−4.51 to −1.27)	<0.001	−0.95 (−1.81 to −0.09)	0.030	0.43 (−0.45 to 1.31)	0.33
Male sex	2.93 (−1.23 to 7.08)	0.167	1.48 (−0.74 to 3.71)	0.192	0.56 (−1.84 to 2.93)	0.65
Education						
11 to 13 yr	5.20 (−0.22 to 10.61)	0.060	0.73 (−2.34 to 3.80)	0.64	−1.07 (−4.21 to 2.06)	0.50
>13 yr/university	7.89 (2.74 to 13.01)	0.003	0.33 (−2.60 to 3.27)	0.82	−0.08 (−3.23 to 3.08)	0.90
BMI						
Overweight (BMI = 25.0 to 29.9 kg/m²)	0.29 (−4.05 to 4.63)	0.90	−0.3 (−2.59 to 1.99)	0.80	−2.15 (−4.37 to 0.07)	0.057
Obesity (BMI ≥30.0 kg/m²)	−6.40 (−11.45 to −1.34)	0.013	−2.49 (−5.10 to 0.12)	0.061	−3.21 (−6.15 to −0.27)	0.032
ASA class						
II. Mild systemic disease	−3.47 (−7.47 to 0.52)	0.089	−3.56 (−5.97 to −1.15)	0.004	1.50 (−0.89 to 3.88)	0.22
III. Severe systemic disease	−16.51 (−28.02 to −5.01)	0.005	−8.54 (−13.14 to −3.93)	<0.001	−0.54 (−5.67 to 4.59)	0.84
Diabetes	−2.36 (−11.21 to 6.50)	0.60	−1.83 (−5.84 to 2.18)	0.37	−4.09 (−9.73 to 1.53)	0.154
Current smoker	−5.44 (−10.47 to −0.41)	0.034	−2.23 (−4.87 to 0.41)	0.097	−6.45 (−9.37 to −3.53)	<0.001
Unimalleolar, bimalleolar, trimalleolar fracture						
Bimalleolar	−3.86 (−9.15 to 1.43)	0.153	−1.86 (−4.37 to 0.66)	0.148	−2.74 (−5.66 to 0.18)	0.066
Trimalleolar	−4.22 (−10.57 to 2.12)	0.192	−0.25 (−3.11 to 2.62)	0.87	−1.36 (−4.48 to 1.76)	0.39
Duration of surgery, per 15 minutes	−0.80 (−1.69 to 0.08)	0.074	−0.38 (−0.83 to 0.07)	0.095	0.13 (−0.28 to 0.54)	0.53
Any complication	−8.59 (−13.46 to −3.72)	0.001	−3.70 (−6.07 to −1.33)	0.002	−0.48 (−3.01 to 2.04)	0.71

*Unstandardized regression coefficient. The 95% CI is given in parentheses.

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.

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/m^2, 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/m^2 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 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						
Overweight (BMI = 25.0 to 29.9 kg/m^2)	−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
Obesity (BMI ≥30.0 kg/m^2)	−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
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
Current smoker	−1.90 (−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

*Unstandardized regression coefficient. The 95% CI is given in parentheses.

sample (Table V). All of the adjustment variables were significantly associated with the PF, PCS, and MCS scores, with the exception of a BMI of 25.0 to 29.9 kg/m^2 for the MCS score.

Discussion

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 ≥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 ≥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[8,9], whereas the associations of fracture type and smoking status with health status and functional outcome were inconclusive[8,10]. 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 >65 and ≤65 years of age, with the exception that the MCS scores were higher in the former group[23]; 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[27] and with functional outcomes determined according to fracture severity with use of different classification systems[28,29]. However, this finding contrasts with a previous report of outcomes being worse for patients with bimalleolar fractures than for those with unimalleolar fractures[30].

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[31-35]. 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[2,8,22,36-38]. One study demonstrated no impairment in health status compared with norms at 1.5 years after ankle surgery[36], another demonstrated comparable results after 2 years except for those on the PF and role-physical scales[8], and 2 other studies demonstrated a worse health status at 2 to 5 years after surgery[22,38]. 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[9]. 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[27]. 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 conducted 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/m^2) 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/m^2 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. ■

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