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Societal burden and quality of life in patients with Lisfranc Injuries

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ABSTRACT

Background: The incidence of Lisfranc fractures is rising, along with the incidence of foot fractures in general. These injuries can lead to long-term healthcare use and societal costs. Current economic evaluation studies are scarce in Lisfranc fracture research, and only investigate the healthcare costs. The aim of the present study was to accurately measure the monetary societal burden of disease and quality of life in the first 6 months after the injury in patients with Lisfranc fractures in the Netherlands.

Materials and methods: This study used a prevalence-based, bottom-up approach. Patients were included through thirteen medical centres in the Netherlands. Both stable and unstable injuries were included. The societal perspective was used. The costs were measured at baseline, 12 weeks and 6 months using the iMTA MCQ and PCQ questionnaires. Reference prices were used for valuation. Quality-of-life was measured using the EQ-5D-5 L and VAS scores.

Results: 214 patients were included. The mean age was 45.9 years, and 24.3% of patients had comorbidities. The baseline questionnaires yielded approximately €2023 as the total societal costs in the 3 months prior to injury. The follow-up questionnaires and surgery costs assessment yielded approximately €17,083 as the total costs in the first 6 months after injury. Of these costs, approximately two thirds could be attributed to productivity losses. The EQ-5D-5 L found a mean index value of 0.449 at baseline and an index value of 0.737 at the 6-month follow-up.

Conclusion: The total monetary societal costs in the first 6 months after injury are approximately €17,083. Approximately two thirds of these costs can be attributed to productivity losses. These costs appear to be somewhat higher than those found in other studies. However, these studies only included the healthcare costs. Furthermore, the baseline costs indicate relatively low healthcare usage before the injury compared to the average Dutch patient. The mean QoL index was 0.462 at baseline and 0.737 at 6 months, indicating a rise in QoL after treatment as well as a long-lasting impact on QoL. To our knowledge, this is only the first study investigating the societal costs of Lisfranc injuries, so more research is needed.

Introduction

The Lisfranc joint complex is a relatively unknown, yet rather important complex formed by the tarsal-metatarsal joints [1]. Trauma can involve the bones in the Lisfranc joint complex fracturing and/or dislocating, causing Lisfranc injuries. These injuries are rare, the total incidence of Lisfranc injuries having been reported to vary from 9.2 to 14 per 100,000 patient-years [2,3], while the incidence of unstable

List of abbreviations: iMTA, Institute of Medical Technology Assessment; MCQ, Medical Consumption Questionnaire; PCQ, Productivity Costs Questionnaire; EQ-5D-5L, EuroQOL - 5 Dimensions - 5 Levels; VAS, Visual Analogue Scale; QoL, Quality of Life; QALY, Quality Adjusted Life Year; ORIF, Open Reduction and Internal Fixation; PA, Primary arthrodesis; RCT, Randomized Controlled Trial; CT, Computed Tomography; BMI, Body Mass Index; CBS, Dutch Central Bureau of Statistics; ZiNL, Dutch National Healthcare Institute.

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fractures is 6 per 100,000 patient-years [2]. However, the incidence of Lisfranc injuries, and foot fractures in general, is increasing [2,3]. Injuries to the Lisfranc joint complex can cause persistent pain and functional limitations, which can result in long-term healthcare dependency with a clinically significant impact on quality of life [4,5].

Studies into the burden of disease have commonly been used to quantify the monetary burden that these injuries can put on the healthcare system and society [6–9]. In the Netherlands, the costs of foot and ankle fractures can add up to €10,949 per case when only the healthcare-related costs are included [10]. In addition to these healthcare costs, injuries can have a substantial impact on society, mainly through the loss of productivity caused by the injury.

To our knowledge, little is known specifically about the costs of Lisfranc injury [9]. The current literature consists of two studies. A cost-effectiveness evaluation regarding purely ligamentous Lisfranc injuries by Albright et al. described a higher incremental cost-effectiveness for open reduction and internal fixation compared to primary arthrodesis [11]. A cost description study by Barnds et al. reported a mean cost of care of €3889.52 for open reduction and internal fixation (ORIF) and €3078.45 for primary arthrodesis (PA) [12]. Both articles describe the costs from a healthcare perspective and did not investigate the societal costs. To our knowledge, no studies have used the societal perspective on costs in Lisfranc injuries. Literature on calcaneal fractures appears to describe a significant impact on society [13–15]. However, the available literature has methodological limitations [9].

The aim of the present study was to accurately measure the monetary societal burden of disease and the quality of life in the first 6 months of injury in patients with both stable and unstable Lisfranc fractures in the Netherlands.

Methods

Study design

This study was conducted in a prevalence-based fashion. It used a bottom-up approach with a sample of patients included in the context of a multicentre, randomized controlled trial (RCT) in the Netherlands which compared the effectiveness and cost-effectiveness of PA and ORIF in unstable Lisfranc injuries [16]. The present study did not distinguish between patients who received PA or ORIF, since both techniques are used equally frequently throughout the world [9].

Patients and setting

Patients were recruited from 13 of the 69 medical centres in the Netherlands. The inclusion period lasted 30 months. Two groups of patients were identified for inclusion in the present study.

The first group consisted of patients who were eligible for enrolment in the RCT. The inclusion criteria for the RCT were as follows: patients were eligible for inclusion if they were over 18 years old, had a traumatic Lisfranc fracture injury that was not older than six weeks and was proven to be displaced or unstable according to stress radiographs – either weight-bearing radiographs or fluoroscopic stress testing under anesthesia when radiograph and CT-scan were not sufficiently clear – and were independent for daily life activities [16]. Patients were excluded if they were below 18 years of age, had an open Lisfranc fracture or a purely ligamentous Lisfranc injury, had a non-displaced and stable injury, had contra-indications for general or locoregional anesthesia, had other fractures regarding the ipsilateral leg, had preexisting abnormalities in the Lisfranc joint complex or immobility, were dependent in daily life activities, had rheumatoid arthritis, had pathological fractures, had peripheral neuropathy or diabetes, or were known to abuse alcohol or drugs which could interfere with adequate follow-up [16].

The second group consisted of patients who were not included in the RCT but had filled in questionnaires at the follow-up stages. All patients had Lisfranc injuries and presented to the emergency department where they were offered to participate in the RCT. If patients were ineligible for inclusion in the RCT, they were still offered to fill out the questionnaires. The main reason for patients not being eligible for inclusion was a stable injury, although there were also patients who were not eligible due to other factors, like unwillingness to receive randomized treatment for unstable injuries.

Data collection

Patients were included over a period between June 2020 and December 2022 [16]. When patients presented at the emergency room, they were given a set of questionnaires. These questionnaires were administered at baseline for both groups, at 12 weeks after surgery for the RCT group, and at 6 months after surgery for both groups. These cost questionnaires reported on the 3 months prior to the administration of the questionnaire. Hence, the baseline questionnaire reported on the 3 months prior to injury, and the 12-week and 6-month questionnaires reported on the 6 months after injury. The non-RCT group did not receive the questionnaires at the 12-week follow-up. To approximate the costs for the non-RCT group at this stage, the average monetary burden of the RCT group as reported on the 12 weeks questionnaire was used as an average. The surgery and hospital admission costs were deducted from this, since these patients were not routinely operated, nor hospitalized.

Data on the quality of life was collected in a similar fashion using the EQ-5D-5 L [17]. This questionnaire reports on the quality of life at the moment of administration of the questionnaire. Next to this, data was collected on age, gender, body mass index (BMI), presence of comorbidities, and Myerson classification, which describes the radiologic incongruity of the tarsometatarsal joints [18,19].

Cost assessment

Cost assessment is usually divided into three stages: identification, measurement, and valuation of costs [9]. These three steps were used in the assessment of costs for the present study and are described below.

Identification of costs

To decide which costs had to be included in the present study, the societal perspective was used, as recommended by the Dutch guidelines [20]. This means that all relevant costs were included, since the societal perspective is best described as the 'aggregation of all perspectives' [21]. These costs included 3 categories: (1) healthcare costs, for example surgery costs, medication costs, outpatient clinic visits, imaging, physical therapy, general practitioner visits, etc.; (2) costs incurred by the patient and their family, for example travelling costs and parking costs, and (3) productivity losses in paid and unpaid work. The questionnaires at baseline included all healthcare use, not limited to the use related to the Lisfranc injury. The questionnaires at 12 weeks and 6 months were reviewed after which reported use of healthcare not related to the Lisfranc injury (i.e., outpatient visits to unrelated specialists, imaging of other body parts than the foot, etc.) was not included in the analysis.

Measurement of costs

All included patients were administered the institute of Medical Technology Assessment (iMTA) Medical Consumption Questionnaire (iMCQ) [16,22] and the iMTA Productivity Costs Questionnaire (iPCQ) [16,23]. These questionnaires measure the costs of healthcare use and productivity losses, respectively, in monetary terms. Both are internationally *acclaimed* questionnaires for use in economic evaluations [22,23]. The iPCQ measures the productivity losses in three categories: (1) absenteeism (2) presenteeism and productivity losses, and (3) loss of unpaid work [24]. These questionnaires were administered at baseline (i.e., between the visit to the emergency department and the surgery), at the 12-week follow-up, and at the 6-month follow-up. The

questionnaires report on healthcare use and productivity losses over the 3 months prior to administration of the questionnaire. The baseline questionnaire is thus used to estimate the healthcare costs and productivity losses over the 3 months prior to the injury. The baseline questionnaire can then be used to gain insight into the overall health status of the population. The follow-up questionnaires assess the costs incurred in the first 6 months of illness, since they are administered at 12 weeks and 6 months after the injury.

Valuation of costs

This study used 2022 as a reference year for all costs. The following strategies were used to value the costs that had previously been measured by the questionnaires. For valuation we used the Dutch manual for costing studies in healthcare, published in 2014 [20,25]. This manual was chosen because the present study includes a Dutch population and therefore using the Dutch reference prices provided the most accurate representation of the burden of disease. The manual provides reference prices to value healthcare costs. We indexed these reference prices for inflation to the year 2022 using the customer price index provided by Statistics Netherlands (CBS) and applied these to the volume measurement conducted by the iMTA MCQ to obtain the monetary costs from this questionnaire.

Regarding the medication costs, the Dutch National HealthCare Institute (ZiNL) has published a website that describes all medication costs. We used this website to value the medication costs in monetary terms [26].

The surgery costs were valued using the Dutch national reimbursement system for healthcare insurances. The primary surgery and possible revision surgeries were valued separately.

For travelling costs, we used the average travelling distance to a particular healthcare provider and multiplied these distances with the number of times patients needed to travel to locations for healthcare (hospital, GP, physiotherapist, etc.), as suggested in the Dutch guidelines [25]. If the specific location was not mentioned in the costing manual, we used the shortest reasonable distance to avoid overestimating the costs.

Productivity losses were valued using the friction costs method, as recommended by the Dutch guidelines. This method assumes that paid workers who are unable to work can be replaced, and the monetary loss of productivity costs are only incurred during the period it takes to hire replacement. Therefore, productivity losses are only valued over this friction period. If patients are absent for a longer time, only the absence within the friction period is counted as carrying a monetary burden. This period depends on the mobility of the job market and on the number of open and filled vacancies [25]. At the time of writing, this friction period was 135 days.

Measuring quality of life

General quality of life entails all aspects, both objective and subjective, that can influence the quality of life of patients [27,28]. The quality of life is most often quantified using quality adjusted life-years (QALYs), which are derived from index values [21]. These values can be measured in numerous ways. As stated above, the present study used the EQ-5D-5L [16], a questionnaire which consists of 5 dimensions, viz. mobility, self-care, daily life activities, pain/discomfort, and depression/anxiety. These dimensions are rated using 5 levels indicating the number of problems in the given dimension [17,29]. This rating results in 3125 possible combinations, ranging from 11,111 (best health) to 55,555 (worst health) [30]. This can be converted into index values to calculate QALYs [31,32]. These index values are calculated by assuming 11,111 as a perfect health state and subtracting a particular value from '1' for every answer that indicates less than perfect health. These values were obtained from Versteegh et al. [33], which is the value set recommended by EuroQOL. The EQ-5D-5L has been validated for use in limb injury [34].

In addition to this questionnaire, participants completed a visual analogue scale (VAS) on which they indicated their overall health perception by scoring it between 100 (perfect health) and 0 (worst possible health); we recorded the average score [16]. Both the EQ-5D-5L and the VAS score measure the quality of life at the moment of administering the questionnaires.

Statistical analysis

Building and maintaining the database, calculating the results, and analysing descriptive statistics were all carried out using the most recent version of Microsoft Excel and IBM SPSS statistics 27. The 95% confidence intervals were calculated by means of bootstrapping, using 1000 random samples. A subgroup analysis was performed for gender and Myerson classification.

Results

Demographics

The present study included 214 patients: 126 were included in the randomized controlled trial, and 88 were only sent the questionnaires. A full overview of the patient demographics is presented in table 1.

The mean age in this group was 45.9 years (±1.17), and the group included 24 patients who were 67 years or older, which is the retirement age in the Netherlands. Most of the patients were female (n = 118, 55.1%). The body mass index (BMI) was divided into the following categories: <18.5 (n = 3), 18.5–24.9 (n = 88), 25–29.9 (n = 84), 30–34.9 (n = 24), 35–39.9 (n = 7), and ≥40 (n = 4). Data on BMI was missing for four patients. Fifty-two patients had comorbidities affecting one or multiple organic systems, the most prominent being cardiovascular, locomotor, neurological, and pulmonary comorbidities. Myerson class B2 fractures were the most common (n = 80), while Myerson class A fractures were also frequently found (n = 35). Other classifications were relatively evenly distributed. The Myerson classification was not assessed in 60 patients.

Costs

At baseline, 209 patients filled in the questionnaires. The total costs reported on both questionnaires plus the travelling costs were €2023.36 [± €530.75] per 3 months (see Table 2).

These costs can be extrapolated to 1 year by multiplying them by 4, giving a total of €8093.44 per year. Approximately half of the total costs could be attributed to productivity losses.

The results of the questionnaires at 12 weeks and 6 months showed

Table 1
Patient demographics.

	n = 214	
Gender (%)	**Male**	96 (44.9%)
	Female	118 (55.1%)
Age; Mean (95% CI)		45.9 (±1.17)
BMI (%)	**<18.5%**	3 (1.4%)
	18.5 – 24.9	88 (41.1%)
	25 – 29.9	84 (39.2%)
	30 – 34.9	24 (11.2%)
	35 – 39.9	7 (3.3%)
	>40	4 (1.9%)
	Missing	4 (1.9%)
Comorbidity present (%)		52 (24.3%)
Myerson class (%)	**A**	35 (16.4%)
	B1	17 (7.9%)
	B2	80 (37.4%)
	C1	9 (4.2%)
	C2	13 (6.1%)
	Not assessed	60 (28.0%)

Table 2
Baseline costs.

	Costs per 3 months, mean (95% CI)
Healthcare costs	€991.01 (± €242.66)
Travelling costs	€15.77 (± €2.84)
Productivity losses	€1016.59 (± €360.96)
Total costs	€2023.36 (± €530.75)

that the mean total costs reported on the combined questionnaires for both follow-up moments were €17,083.64 [± €1634.68] (see Table 3).

The mean total healthcare costs reported by patients on the iMCQ were €3354.20 [± €1024.97]. The surgeries that patients underwent accounted for €2605.95 [± €302.40]. The mean travelling costs were €47.08 (± €4.82). The mean costs attributable to productivity losses were €11,239.31 (± €1282.14).

Quality of life

At baseline, 209 patients filled out the questionnaires, while five patients did not. At 3 months, only the patients who were included in the RCT were sent the questionnaires. Of these 127 patients, three did not fill in the questionnaire. At 6 months, 192 patients filled out the questionnaires. The mean index values were 0.449 [± 0.427] at baseline, 0.644 [± 0,400] at 3 months, and 0.737 [± 0.280] at 6 months. These index values, which were individually calculated, ranged from 1 (perfect health) to -0.391 (worst health). The mean VAS scores were 65.41 [± 2.61] at baseline, 72,36 [± 2.80] at 3 months, and 75.64 [± 2.12] at 6 months. A full overview of the scores in the EQ-5D-5L is provided in Table 4.

Subgroup analyses

A subgroup analysis was performed regarding gender. The total costs were €16,410.33 [± €2293.26] for males and €17,631.41 [± €2264.47] for females. Another subgroup analysis was performed for the Myerson classification (see Table 5).

Discussion

The aim of the present study was to accurately measure the monetary societal burden of disease, as well as the baseline quality of life, in patients with Lisfranc fractures.

Our study found somewhat higher costs than those reported in a study by Barnds et al., who found average healthcare costs of €3889.52 for ORIF and €3078.45 for PA [12]. Our study found the mean healthcare costs over the first 6 months to be €5960.15. Barnds et al. used health activities recorded in a retrospective database. It is possible that the difference with our findings can be explained by our use of the iMCQ, which may have a broader scope. In addition, inflation may have played a role in the difference, since the interval between the studies was 5 years. Albright et al. performed a cost-effectiveness analysis in which the costs were presented as a fraction per QALY gained, making these costs difficult to compare with our findings [11]. Furthermore, a study by De Boer et al. found the total healthcare costs of foot and ankle fractures in the Netherlands to be €6023 in elderly men and €10,949 in elderly women [10]. The difference with our findings could be explained by the relatively young population in our study.

We found that almost two thirds of the costs found in our study was attributable to productivity losses. To our knowledge, this study is the first to report on the societal costs of Lisfranc fractures. However, economic evaluations regarding calcaneal fractures indicate a significant influence of societal costs on the total costs [13–15]. These findings underline the importance of the societal perspective.

We measured the baseline costs covering the 3 months prior to the injury. The mean costs at baseline were €2023.36 over 3 months. The average monetary healthcare costs per citizen in the Netherlands were €5600 per year in 2019 [35], which corresponds to €6494.33 when indexed for inflation. Considering that productivity losses were not accounted for in the Dutch average, and approximately half of the baseline costs in the present study can be attributed to productivity losses, we can conclude that our study population had a relatively lower monetary burden of disease than the average Dutch patient. This indicates a relatively healthy population prior to the injury.

Lisfranc injuries were more common in women (55.1%) than in men (44.9%). This is consistent with the most recent epidemiologic literature regarding Lisfranc injuries by Stødle et al. [2]. Moreover, the mean age in our study population was 45.9 years, which appears to be relatively young compared to the mean age of 57.9 years in general fracture cases reported by Bergh et al. [36]. This could be attributable to a relatively young population being more active, which leads to more Lisfranc injuries. The most common Myerson classifications were A and B2.

The quality-of-life aspect of this study yielded an index value 0.449 at baseline and 0.737 at 6 months follow-up. The index value at baseline was relatively low, which is most obviously attributable to the injury. The index value rose over time and was higher at the 6-month follow-up. The mean index value for Dutch adults is 0.869 [33], so the mean index value in our population was lower, even at the 6-month follow-up. Although this indicates improvement in the quality of life after treatment for Lisfranc fractures, it still shows a significant impact on short- and long-term quality of life.

The present study has multiple limitations. Firstly, since we used patient-reported outcomes, the data was susceptible to errors. We encountered multiple answers that were outliers. In these cases, the

Table 3
Costs over the first 6 months of illness.

	12 weeks follow up, mean (95% CI)	6 months follow up, mean (95% CI)	Total costs, mean (95% CI)
Healthcare costs (iMCQ)	€2441.92 (± €678.87)	€912.28 (± €444.57)	€3354.20 (± €1024.97)
Healthcare costs (operation)	€2443.04 (± €275.31)	€162.92 (± €72.56)	€2605.95 (± €302.40)
Travelling costs	€30.58 (± €3.83)	€16.50 (± €2.27)	€47.08 (± €4.82)
Productivity losses	€8864.55 (± €965.94)	€2374.77 (± €617.14)	€11,239.31 (± €1282.14)
Total costs			€17,083.64 (± €1634.68)

Table 4
Results of EQ-5D-5L questionnaires at different timepoints.

	Baseline (Mean [±SD])	3 Months (Mean [±SD])	6 Months (Mean [±SD])
Mobility	3.87 [± 0.22]	2.74 [± 0.16]	2.27 [± 0.12]
Self-Care	2.21 [± 0.08]	1.31 [± 0.12]	1.17 [± 0.08]
Usual activities	3.48 [± 0.20]	2,65 [± 0.16]	2.05 [± 0.14]
Pain/Discomfort	2.61 [± 0.14]	2.53 [± 1.4]	2.29 [± 0.12]
Anxiety/ Depression	1.82 [± 0.14]	1.62 [± 0.16]	1.51 [± 0.12]
Index value	0.449 [± 0.427]	0.644 [± 0,400]	0.737 [± 0.280]
VAS score	65.41 [± 2.61]	72,36 [± 2.80]	75.64 [± 2.12]

Table 5
Subgroup analysis of the Myerson classification.

Myerson classification	Total costs (95% CI)
Class A	€18,387.38 (± €4016.32)
Class B1	€18,934.11 (± €4755.78)
Class B2	€17,661.95 (± €3203.93)
Class C1	€12,535.15 (± €4565.47)
Class C2	€22,197.08 (± €6252.14)
Not assessed	€14,602.09 (± €2182.78)

patient was contacted. If patients could not be reached, an estimation was made at the lowest reasonable value to avoid overestimation of costs. This could have influenced our results. Secondly, patients possibly reported lower healthcare use than would normally be required. For example, when comparing the reported use with the relevant protocol for follow-up, these two did not match for some patients. This may have led to our study finding relatively lower costs. Thirdly, we used the most recent Dutch costing manual, which was published in 2014 and supplied us with reference prices. This was the most accurate available pricing, and we indexed for inflation. Despite this, society and the healthcare system have evolved in the past decade, which may have influenced the accuracy of the reference prices we used. Fourthly, the productivity losses were measured using the friction costs method, which uses the mobility of the job market to estimate the time it takes to replace employees. At the time of writing, the job market is unstable and therefore it takes relatively long to find replacement staff. This might not be true in the future. Therefore, the costs incurred from productivity losses may be lower in a more stable job market.

Conclusion

The present study has yielded a description of the monetary burden of disease in Lisfranc injuries. We found results that were somewhat higher than those of the few existing studies. However, this was the first study to assess these costs from a societal perspective. Therefore, we believe more research is necessary into the societal burden of disease in Lisfranc injuries.

Combining the results gained from all three questionnaires and calculating the associated costs yields total monetary societal costs in the first 6 months after Lisfranc injury of €17,083.64 [± €1634.68]. The mean baseline costs were €2023.36 (± €530.75), indicating a relatively healthy population. The mean index value was 0.449 at baseline and 0.737 at the 6-month follow-up.

Declaration of Competing Interest

The authors of this article have no competing interests to declare

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Appendix 1

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