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## Alternative approaches to derive disability weights in injuries: do they make a difference?

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### Abstract

**Background** In burden of disease studies, several approaches are used to assess disability weights, a scaling factor necessary to compute years lived with disability (YLD). The aim of this study was to quantify disability weights for injury consequences with two competing approaches, (a) standard QALY/DALY model (SQM) which derives disability weights from patient survey data and (b) the annual profile model (APM) which derives weights for the same patient data valued by a panel.

**Methods** Disability weights were assessed using (a) EQ-5D data from a postal survey among 8,564 injury patients 2½, 5, and 9 months after attending the Emergency Department, and (b) preferences of 143 laymen elicited with the time trade-off method.

**Results** Compared with APM, SQM disability weights were consistently higher. YLD calculated with SQM disability weights was more than three times higher compared

with YLD calculated with APM disability weights, for mild injuries with short duration, this increase was six fold.

**Conclusions** The APM seems the preferred method in burden of injury studies that includes mild conditions with a rapid course, since the SQM approach might overestimate the impact of the latter. The APM, however, might underestimate the impact of injury consequences, especially in case of severe injuries.

**Keywords** Burden of illness · Injuries · Quality-adjusted life years · Utility

### Abbreviations

APM	Annual profile model
DALY	Disability adjusted life years
ED	Emergency department
EQ-5D	EuroQol-5D
ICD	International statistical classification of disease, Injuries and causes of death
QALY	Quality adjusted life years
SQM	Standard QALY/DALY model
TTO	Time trade-off technique
YLD	Years lived with disability
YLL	Years of life lost
VAS	Visual analogue scale

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### Background

Since the application of the concept in 1993, the Disability Adjusted Life Year (DALY) is used increasingly for priority setting in health care and prevention [1]. The DALY is a health gap measure that aggregates mortality and morbidity data, thus allowing comparison of population health status between countries as well as comparison

between diseases within a country [2]. To aggregate mortality and morbidity data, years of life lost due to premature mortality (YLL) and years lived with disability (YLD) have to be established. Essential for the latter is the disability weight; a scaling factor that expresses the impact of a disease with a value ranging from 0, indicating the best possible health state, through 1, indicating worst possible health state [3]. By multiplying the disability weight of a condition by its incidence and its average duration (or prevalence in case of chronic disease), the healthy time lost due to living with disability (YLD) is calculated.

Regarding disability weights, there are two dominant approaches, both have been used in burden of disease studies. One of these approaches is to adopt existing disability weights from the Global Burden of Disease study [4]. In order to compute YLD, the GBD disability weights are then applied using the standard QALY/DALY model (SQM). The SQM assumes independence between duration and disability and it requires that the health state remains fixed over time [5–7]. For health states with dynamic and/or complex patterns this assumption is untenable, since these health states in fact have to be separated into numerous parts.

A field abundant of dynamic recovery patterns with a wide variation in duration is the field of injuries. Moreover, the existing set of disability weights as published by Murray et al. [4] lacks a number of highly incident non-ignorable long-term injury consequences, which ultimately results in an underestimation of the total burden of injury. To address both the issue of complexity over time and the issue of incomplete coverage of long-term sequelae, existing methods have to be adapted or extended. At this stage, the SQM approach has been administered to several burden of injury studies [8–11]. This approach uses a two-step procedure to assign disability weights to health outcomes. Firstly, patients report their own health state using one of the available generic health state classification systems. These classification systems render the health state of an individual by the function level that he/she reports on each of the domains. The weight of that health state is computed by a formula that firstly yields a partial weight score for each domain depending on the reported level, and subsequently adds partial weights which by definition fit within the 0.0–1.0 range. The partial weights of the formula, the tariff weights, are derived at an earlier stage from preference data of the population [12]. The three most commonly used systems are the EuroQol-5D (EQ-5D), the Health Utility Index, and the Quality of Well-Being Scale [13–15].

An alternative method used in burden of disease and injury studies is to obtain disability weights directly using the annual profile model (APM) [16, 17]. Unlike the SQM, the APM describes the course of the condition over 1-year

time, allowing assessment of disability weights for health states characterized by an acute onset and complex patterns of recovery. The measurement techniques to elicit the preference weights are, however, identical [16].

The aims of this study were to quantify differences between (a) disability weights for injury consequences derived from patient reported EQ-5D classification data using the SQM and (b) disability weights derived with panel elicitation using the APM, and subsequently compare YLD estimations calculated with both sets of disability weights given similar incidence data. Based on this comparison, we aimed to decide on the preference of APM above SQM in injuries.

## Methods

For the selection of the injury consequences, the EURO-COST injury classification was used [18]. This classification is compatible to the International Statistical Classification of Disease, Injuries, and Causes of Death—ninth and tenth revision (ICD-9 and 10) classification system.

For assessment of the SQM and APM disability weights, data from two studies were used (1) the EQ-5D that was included in a questionnaire held among injury patients who attended the Emergency Department (ED) [9] and (2) health state valuations derived with APM panel elicitation using the visual analogue scale (VAS) and time trade-off (TTO) technique [17].

### SQM disability weights

A sample of 8,564 injury patients aged 15 years and older was sent a postal questionnaire 2½ months after they attended the ED of a hospital in The Netherlands [9]. At 5 and 9 months, a follow-up questionnaire was sent to patients that responded to the preceding questionnaire. The sustained injuries varied from minor to severe and the sample included hospitalized and non-hospitalized patients. The sample of patients was stratified, over sampling patients with severe injuries. To measure functional outcome after injury, the questionnaires included the EQ-5D and the VAS. With the EQ-5D classification system, subjects describe their health in three levels of severity in the dimensions mobility, self-care, usual activities, pain/discomfort, and anxiety/depression [19]. Subsequently, the reported health states were converted into utility scores using a pre-existing set of preference weights based on preference data from the general population of The Netherlands [20]. To adjust the data for non-response, a non-response analysis was performed by multivariate logistic regression, testing variables age, sex, type of injury, external cause of the injury, hospitalization and

length of stay, health status, and ambulance transport as possible determinants of non-response. The significant variables ( $P < 0.05$ ) were used to yield non-response weights for the sample of patients treated at the ED. Additionally, the data were adjusted for stratification of the sample of ED patients [9]. The resulting weighted data can be considered representative for an ED population of injury patients in The Netherlands. We used the weighted data to calculate the EQ-5D utility scores and included only patients who filled out all three questionnaires. For the subsequent calculation of the EQ-5D disability weights, we used the population health index of the population of the United Kingdom, adjusted for age and sex [21]. In order to determine the SQM disability weights per injury group over 1-year time, the resulting 2½-month (T1), 5-month (T2), and 9-month (T3) disability weights were aggregated with the following formula: (T1 weight + T2 weight + T3 weight)/3. This formula was also used to calculate the aggregated VAS values per injury group over 1-year time.

#### APM disability weights

The APM disability weights were derived using the Dutch Disability Weights protocol with two noted modifications [22]. Firstly, a population panel rather than a panel of medical experts provided the values. The population panel ( $n = 143$ ) was randomly selected from an existing panel of 560 people that was recruited from the general public through an advertisement in a free newspaper that is available throughout The Netherlands. Secondly, the VAS and the TTO preference measurement methods were used to value a number of injury related health states. The VAS valuation technique requires participants to score the disease stage on a vertical thermometer graded from 0 (worst possible health state) to 100 (best possible health state). The TTO asks participants how many days of 1 year in full health, they are willing to trade in order to be restored from the presented disease stage. Similarly to the Dutch Disability Weights study, the health states were described on a standardized 210 by 297 mm (A4) sized vignette which contained disease specific information in laymen terminology, a generic EQ-5D profile of the health state and an annual profile. This annual profile describes the course of the health state—the disability profile—over 1-year time, allowing assessment of diseases and injuries with a rapid course and/or complex recovery patterns [16]. Additionally, information on the location of the injury and physical alterations caused by the health state was provided. To enhance information processing, we used graphics and colors in the description and we intensively explained the health state descriptions during the panel session. Each participant valued 32 health states, 10 health states during a 3 h panel session and subsequently 22

health states in a questionnaire, they received at home. The order of the presented health states was randomized.

#### Analysis

The questionnaire rendered SQM disability weights for 32 injury groups. For 11 of these injury groups, no matching APM disability weights were available. Hence, 21 injury groups were included in the comparison between SQM and APM disability weights. For each injury group absolute difference between SQM and APM disability weights as well as SQM/APM disability weight ratio was calculated. A regression analysis was performed to determine if age and sex had significant effects on APM disability weights. The 21 injury groups were categorized into three severity classes. These injury severity classes were grouped post hoc according to the calculated APM disability weights as previously tested by an international expert group [23]. Three injury severity classes were distinguished: mild, moderate, and severe, using 0.03 and 0.10 as cut-off points. Differences between SQM and APM and ratios were calculated by injury severity class. Per injury severity class, YLDs were computed with both SQM and APM disability weights to compare the proportion YLDs lost due to mild, moderate, and severe injury consequences. To calculate YLDs lost in the first year after the injury, the incidence data (year 2002) derived from the Dutch Injury Surveillance system were used. The Dutch Injury Surveillance system is a permanent registry of injury victims treated at the Emergency Department of 15 hospitals in The Netherlands [24]. The Spearman's rank correlation coefficient was calculated to test if the SQM and APM ranking based on the mean disability weights of the 21 injury consequences were associated. The Pearson correlation coefficient was used to test whether the distributions of the SQM and APM disability weights assigned to the injury consequences were correlated.

## Results

### Respondents

Of the 1,392 injury patients that completed the patient surveys 2½, 5, and 9 months after attending the ED 53% were male and mean age was 43 years old. The panel study was attended by 143 lay persons. Of these lay persons, 59 (41%) were male and mean age was 48 years old.

### Comparison of SQM and APM disability weights

Table 1 shows that the patient reported 2½-month disability weights were the highest and the 9-month disability

**Table 1** Disability weights derived with the standard QALY/DALY model (SQM) at 2½ (T1), 5 (T2), and 9 (T3) months follow-up, per injury group

Injury group	T1		T2		T3	
	DW <sup>a</sup>	SD <sup>b</sup>	DW <sup>a</sup>	SD <sup>b</sup>	DW <sup>a</sup>	SD <sup>b</sup>
<i>Head injury</i>						
Concussion	0.14	0.22	0.08	0.19	0.04	0.11
Eye injury	0.02	0.06	0.05	0.15	0.01	0.03
Fracture facial bones	0.06	0.09	0.06	0.12	0.01	0.03
<i>Injury of spinal cord/thorax/pelvis</i>						
Fract/disl/spr/str vertebral column	0.21	0.21	0.13	0.18	0.10	0.14
Spinal cord injury	0.53	0.23	0.58	0.28	0.54	0.45
Fracture rib/sternum	0.11	0.20	0.09	0.16	0.08	0.18
Fracture pelvis	0.19	0.20	0.14	0.18	0.16	0.15
<i>Injury of upper extremity</i>						
Fracture clavícula/scapula	0.11	0.14	0.03	0.08	0.02	0.08
Fracture elbow/fore arm	0.15	0.16	0.02	0.06	0.03	0.07
Fracture wrist	0.09	0.14	0.05	0.13	<0.01	0.03
Fracture hand/fingers	0.12	0.15	0.07	0.16	0.07	0.21
Disl/sprain/strain shoulder/elbow	0.12	0.13	0.05	0.10	0.04	0.09
Disl/sprain/strain wrist/hand/fingers	0.09	0.19	0.05	0.16	0.03	0.11
<i>Injury of lower extremity</i>						
Fracture hip	0.29	0.30	0.22	0.26	0.18	0.28
Fracture knee/lower leg	0.24	0.21	0.11	0.17	0.07	0.14
Fracture ankle	0.16	0.18	0.08	0.13	0.06	0.11
Fracture foot/toes	0.06	0.11	0.04	0.09	0.03	0.07
Disl/sprain/strain ankle/foot	0.12	0.13	0.07	0.13	0.09	0.16
Disl/sprain/strain hip	0.22	0.23	0.13	0.21	0.15	0.26
<i>External injury</i>						
Superficial injury	0.12	0.19	0.07	0.16	0.05	0.15
Open wound	0.07	0.11	0.02	0.07	0.01	0.02

SQM = disability weight derived from patient reported EQ-5D data, adjusted for age and sex

<sup>a</sup> DW = disability weights; 0 = full health; 1 = worst possible health state

<sup>b</sup> SD = standard deviation

weights were the lowest for all injury groups except spinal cord injury. With both SQM and APM disability weights, 0 indicates the best possible health state and 1 indicates worst possible health state.

The mean SQM and APM disability weights are presented in Table 2. The mean SQM disability weights ranged from 0.03 (eye injury and open wound) to 0.55 (spinal cord injury). The mean APM disability weights ranged from 0.002 (eye injury) to 0.57 (spinal cord injury). For 19 of the total 21 injury consequences, mean SQM disability weights were higher compared with APM disability weights, the difference ranging from 0.004 (fracture

**Table 2** Disability weights derived with the standard QALY/DALY model (SQM) and the annual profile model (APM), per injury group

Injury group	SQM <sup>a</sup>		APM <sup>b</sup>		$\Delta^c$	Ratio
	DW <sup>c</sup>	SD <sup>d</sup>	DW <sup>c</sup>	SD <sup>d</sup>		
<i>Head injury</i>						
Concussion	0.088	0.13	0.015	0.02	0.07	5.9
Eye injury	0.027	0.06	0.002	0.01	0.02	13.4
Fracture facial bones	0.041	0.06	0.018	0.04	0.02	2.3
<i>Injury of spinal cord/thorax/pelvis</i>						
Fract/disl/spr/str vertebral column	0.147	0.14	0.108	0.17	0.04	1.4
Spinal cord injury	0.551	0.29	0.567	0.32	0.02	1.0
Fracture rib/sternum	0.092	0.17	0.045	0.04	0.05	2.0
Fracture pelvis	0.155	0.15	0.150	0.13	0.01	1.0
<i>Injury of upper extremity</i>						
Fracture clavícula/scapula	0.054	0.09	0.050	0.07	<0.01	1.1
Fracture elbow/fore arm	0.065	0.07	0.031	0.06	0.03	2.1
Fracture wrist	0.047	0.07	0.054	0.11	0.01	0.9
Fracture hand/fingers	0.086	0.16	0.016	0.05	0.07	5.4
Disl/sprain/strain shoulder/elbow	0.073	0.08	0.036	0.06	0.04	2.0
Disl/sprain/strain wrist/hand/fingers	0.057	0.15	0.027	0.05	0.03	2.1
<i>Injury of lower extremity</i>						
Fracture hip	0.231	0.27	0.202	0.17	0.03	1.1
Fracture knee/lower leg	0.139	0.15	0.049	0.09	0.09	2.8
Fracture ankle	0.102	0.11	0.056	0.08	0.05	1.8
Fracture foot/toes	0.044	0.08	0.014	0.02	0.03	3.1
Disl/sprain/strain ankle/foot	0.093	0.13	0.026	0.03	0.07	3.6
Disl/sprain/strain hip	0.166	0.19	0.072	0.08	0.09	2.3
<i>External injury</i>						
Superficial injury	0.079	0.15	0.006	0.01	0.07	13.2
Open wound	0.032	0.06	0.013	0.01	0.02	2.5

<sup>a</sup> SQM = disability weight derived from patient reported EQ-5D data, adjusted for age and sex

<sup>b</sup> APM = disability weight derived from panel elicitation using the annual profile approach

<sup>c</sup> DW = disability weight; 0 = full health; 1 = worst possible health state

<sup>d</sup> SD = standard deviation

<sup>e</sup>  $\Delta$  = absolute difference between SQM and APM disability weights

clavícula/scapula) to 0.09 (dislocation/sprain/strain hip and fracture knee/lower leg), with a mean difference of 0.04.

The mean SQM disability weights for eye injury and superficial injury were both thirteen times higher than the APM disability weights. For the two injury groups concussion and fracture of hand/fingers, the SQM disability weights were more than 5 times higher.

Table 3 shows that the largest absolute differences and SQM/APM disability weights ratio were found for mild injuries (mean difference of 0.05, mean ratio of 4).

**Table 3** Disability weights derived with the standard QALY/DALY model (SQM) and the annual profile model (APM), per severity class

Injury severity class	SQM <sup>a</sup>	APM <sup>b</sup>	$\Delta^c$	Ratio
Mild (APM disability weight <0.03)	0.061	0.015	0.05	4.0
Moderate (APM disability weight 0.03–0.10)	0.092	0.049	0.04	1.9
Severe (APM disability weight >0.10)	0.271	0.257	0.01	1.1

<sup>a</sup> SQM = derived from patient reported EQ-5D data, adjusted for age and sex

<sup>b</sup> APM = derived from panel elicitation using the annual profile approach

<sup>c</sup>  $\Delta$  = absolute difference between SQM and APM disability weights

Correlation coefficients between SQM and APM disability weights were high, Pearson's correlation coefficient was 0.93 and Spearman correlation coefficient was 0.65. No significant effects of age and sex on the TTO values were shown.

#### Comparison of VAS values

In Table 4, the mean VAS values derived from the injury patients and the population panel are presented. The VAS values were the lowest for eye injury (injury patients 0.12; population panel 0.07) and the highest for spinal cord injury (injury patients 0.59; population panel 0.87). Except for injury groups eye injury, dislocation/sprain/strain ankle/foot, and superficial injury, the patient reported VAS values were lower compared with the mean VAS values of the corresponding injury groups derived from the population panel, with a mean difference of 0.09. Pearson's correlation coefficient between mean SQM and APM VAS values was 0.90 and Spearman correlation coefficient was 0.75.

#### Comparison of YLD estimations

Table 5 shows the YLD estimations calculated with (a) the set of SQM disability weights and (b) the set of APM disability weights.

Application of the APM disability weights resulted in 16,947 YLDs lost, whereas application of the SQM disability weights resulted in 54,159 YLDs lost, an increase of 320% compared with the YLD estimation with APM disability weights.

With SQM disability weights, most YLDs were lost due to superficial injury (23,219 YLDs) and dislocation/sprain/strain of ankle and foot (4,543 YLDs). Together these two injury consequences accounted for 51% of the YLDs lost. This in contrast to the YLD estimation calculated with APM disability weights, where superficial injury (1,763 YLDs) and dislocation/sprain/strain of ankle and foot (1,270 YLDs) together accounted for only 18% of YLDs

**Table 4** Mean SQM VAS values reported by injury patients and mean APM VAS values derived from the population panel, per injury group

Injury group	SQM <sup>a</sup>		APM <sup>b</sup>		$\Delta^c$	Ratio
	VAS <sup>c</sup>	SD <sup>d</sup>	VAS <sup>c</sup>	SD <sup>d</sup>		
<i>Head injury</i>						
Concussion	0.17	0.16	0.20	0.12	0.03	0.9
Eye injury	0.12	0.09	0.07	0.11	0.05	1.7
Fracture facial bones	0.18	0.11	0.20	0.13	0.02	0.9
<i>Injury of spinal cord/thorax/pelvis</i>						
Fract/disl/spr/str vertebral column	0.33	0.17	0.38	0.17	0.05	0.9
Spinal cord injury	0.59	0.20	0.87	0.11	0.28	0.8
Fracture rib/sternum	0.22	0.14	0.29	0.13	0.07	0.8
Fracture pelvis	0.36	0.14	0.50	0.10	0.14	0.7
<i>Injury of upper extremity</i>						
Fracture clavícula/scapula	0.15	0.15	0.28	0.11	0.13	0.5
Fracture elbow/fore arm	0.14	0.14	0.25	0.09	0.11	0.6
Fracture wrist	0.12	0.12	0.30	0.12	0.18	0.4
Fracture hand/fingers	0.14	0.13	0.16	0.11	0.02	0.9
Disl/sprain/strain shoulder/elbow	0.18	0.15	0.29	0.11	0.11	0.6
Disl/sprain/strain wrist/hand/fingers	0.15	0.13	0.23	0.12	0.08	0.7
<i>Injury of lower extremity</i>						
Fracture hip	0.41	0.20	0.46	0.13	0.05	0.9
Fracture knee/lower leg	0.22	0.17	0.34	0.14	0.12	0.6
Fracture ankle	0.21	0.17	0.34	0.13	0.13	0.6
Fracture foot/toes	0.14	0.10	0.18	0.08	0.04	0.8
Disl/sprain/strain ankle/foot	0.21	0.18	0.19	0.10	0.02	1.1
Disl/sprain/strain hip	0.32	0.19	0.39	0.12	0.07	0.8
<i>External injury</i>						
Superficial injury	0.21	0.17	0.09	0.07	0.12	2.3
Open wound	0.12	0.13	0.14	0.13	0.02	0.9

<sup>a</sup> SQM = VAS value derived from patient reported EQ-5D data

<sup>b</sup> APM = VAS value derived from panel elicitation using the annual profile approach

<sup>c</sup> VAS = VAS value; 0 = full health; 1 = worst possible health state

<sup>d</sup> SD = standard deviation

<sup>e</sup>  $\Delta$  = absolute difference between SQM and APM disability weights

lost. With the APM disability weights, most YLDs were lost due to hip fracture (3,140 YLDs), contributing 19% of YLDs lost.

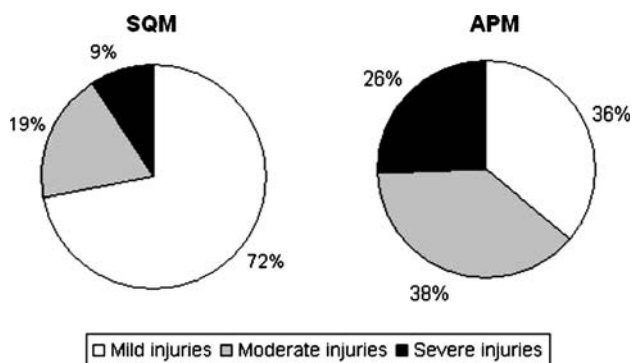
As shown in Fig. 1, with the application of SQM disability weights, the majority (72%, 38,920 YLDs) of the total number of YLDs were lost due to mild injuries with a rapid course. With the APM disability weights 36% (6,112 YLDs) of the total number of YLDs were lost due to mild injuries.

**Table 5** Incidence and YLD estimations calculated with standard QALY/DALY model (SQM) and annual profile model (APM) disability weights, per injury group

Injury group	Incidence	SQM <sup>a</sup>		APM <sup>b</sup>	
		YLD	%	YLD	%
<i>Head injury</i>					
Concussion	15,000	1,349	2.5	230	1.4
Eye injury	25,000	687	1.3	51	0.3
Fracture facial bones	7,400	303	0.6	133	0.8
<i>Injury of spinal cord/thorax/pelvis</i>					
Fractures/disl/spr/str vertebral column	4,400	650	1.2	477	2.8
Spinal cord injury	460	256	0.5	264	1.6
Fracture rib/sternum	5,000	463	0.9	227	1.3
Fracture pelvis	3,200	499	0.9	483	2.8
<i>Injury of upper extremity</i>					
Fracture clavícula/scapula	16,000	869	1.6	804	4.7
Fracture elbow/forearm	27,000	1,727	3.2	824	4.9
Fracture wrist	41,000	1,926	3.6	2,213	13.1
Fracture hand/fingers	45,000	3,881	7.2	722	4.3
Disl/sprain/strain shoulder/elbow	15,000	1,095	2.0	540	3.2
Disl/sprain/strain wrist/hand/fingers	12,000	704	1.3	334	2.0
<i>Injury of lower extremity</i>					
Fracture hip	16,000	3,591	6.6	3,140	18.5
Fracture knee/lower leg	13,000	1,857	3.4	654	3.9
Fracture ankle	18,000	1,814	3.3	996	5.9
Fracture foot/toes	29,000	1,261	2.3	401	2.4
Disl/sprain/strain ankle/foot	49,000	4,543	8.4	1,270	7.5
Disl/sprain hip	3,000	492	0.9	213	1.3
<i>External injury</i>					
Superficial injury	290,000	23,219	42.9	1,763	10.4
Open wound	93,000	2,972	5.5	1,207	7.1
Total	730,000	54,159	100	16,947	100

<sup>a</sup> SQM = YLD calculated with disability weights derived from patient reported EQ-5D data, adjusted for age and sex

<sup>b</sup> APM = YLD calculated with disability weights derived from panel elicitation using the annual profile approach



**Fig. 1** Percentage of YLDs lost due to mild, moderate and severe injuries, calculated with standard QALY/DALY model (SQM) annual profile model (APM) disability weights

## Discussion

The results showed that, although ranking of both sets of disability weights were concordant, the disability weights

obtained with the SQM were consistently higher compared with disability weights obtained with the APM. The difference was relatively large for mild injuries with a rapid course, like eye injury and superficial injury. Application of the SQM disability weights resulted in over three times as many YLDs lost in the first year after the injury compared with the YLD estimation with APM disability weights. For mild injury consequences, this increase was six fold.

Unexpectedly, the VAS values showed the opposite compared with the disability weights obtained with the TTO. With VAS, the population panel valued the health states worse than the patients did. Contrastingly to the TTO, the VAS valuation technique is not choice-based because it does not require the participants to make a trade-off between something valuable, time in case of the TTO, and health. However, this trade-off provides essential information about the relative (un)desirability of a certain health state compared with other health states. This makes

the TTO values more appropriate for burden of disease studies.

The commonly used SQM method consists of adding up separately valued periods lived in a certain health state. It assumes that the value of the health state is not affected by the duration of the health state, nor by the sequence of the health states. Furthermore, during the separate periods the health state is assumed to remain constant [5, 6]. To meet the assumption of constant disability, in order to assess the SQM disability weights, we aggregated three periods of equal length valued at fixed points in time that were similar for each of the injury consequences. However, mild injuries with a rapid course consist of a sequence of much shorter periods of different disability levels. As a consequence, assuming constant health for a relatively long period might overestimate the actual impact of the injury consequences.

Reporting bias might also have contributed to the relatively high SQM disability weights. The SQM disability weights were derived from self-reported EQ-5D health status. Self-reported health status, however, might differ from the actual health status. Grootendorst et al. [25] showed that respondents reported more dysfunction in self-completed questionnaires compared with interview-administered responses. A factor that affects the responses to self-reported health questions are preceding questions [26]. In the questionnaire sent to the injury patients, the EQ-5D was preceded by questions regarding the cause and immediate consequences of the sustained injury. This might have caused the injury patients to overemphasize their level of dysfunction at follow-up.

A third aspect that may have affected the SQM disability weights is the baseline information used to calculate the disability weights. In the current study, we used population utility scores as a baseline. However, Cameron et al. [27] showed that pre-existing morbidity in a cohort of injured patients is higher compared with non-injured individuals. These findings of high pre-existing morbidity among injured patients are accorded by Wardle et al. and Polinder et al. [9, 28]. This implies that pre-injury utility scores are in fact lower than utility scores of the population. Therefore, using population utility scores as a baseline instead of pre-injury utility scores results in larger differences in health-related quality of life, and consequently higher SQM disability weights. Additionally, it should be noted that we have used UK population utility scores as a baseline, because EQ-5D population utility scores for The Netherlands are not available. The population health index of the UK, however, might not be comparable to the Dutch population health index.

For the calculation of the APM disability weights, a baseline utility is not required. Moreover, the APM avoids the assumption of constant disability. Rather than

aggregating separately valued periods, the APM describes the disability profile of the condition—with generic as well as disease specific information—over the course of 1 year [16]. The APM allows a fixed preference-based threshold to distinguish trivial from minimal relevant disease [29]. As shown by the results, the relatively high values of the SQM disability weights for mild injuries with a rapid course in combination with high incidence result in a larger number of total YLDs, and may lead to policy priority of these mild injuries above severe, less frequently occurring injury consequences. This bias in the application of burden of disease estimates in prioritization issues is avoided by the APM threshold, which implies that only if more than 50% of participants are willing to trade-off any time, injuries are regarded as relevant [30]. If the cut-off point is not met, the injuries are excluded from the burden of injury calculation. In the current study, two injury groups did not meet the preference-based threshold, namely eye injury and superficial injury. If these two injury groups are excluded from the burden of disease calculations, the total number of YLDs calculated with the set of SQM disability weights will decrease from 54,159 to 30,253, with 49% of YLDs lost to mild injuries. The burden of disease calculated with APM disability weights will decrease from 16,947 to 15,133 YLDs, with 22% lost due to mild injuries.

On the other hand, the APM panel elicited disability weights have several limitations. Firstly, for any new health state, health state valuations have to be obtained by a new panel study in order to derive the disability weights. A second limitation of APM is that, although EQ-5D data from actual patients is used for the description of the health state, the APM disability weights are not able to capture the heterogeneity of the injury consequences as well as SQM disability weights, which are based on individual patient data. For instance, the consequences and duration of an open wound are highly dependent on the size of the wound and the location on the body. The APM health state description of open wound does not capture this variation. Moreover, several studies showed that variation in injury consequences increases with injury severity and duration [10, 31]. As a result, actual health states of injury patients may differ considerably from the health state descriptions valued with the APM, especially in case of severe injury consequences.

Also, it should be noted that although laypeople may be able to value highly incident injury consequences such as superficial injury and wrist fracture, it may be difficult for them to fully comprehend the impact of less frequently occurring injury consequences on the daily life of a patient living in the particular health state. Inconsistencies in the TTO valuations of severe injury consequences indicate that laypeople are less able to discriminate between severe injury consequences when using the conceptually difficult

TTO valuation technique [17]. Hence, to calculate YLDs for severe long-term injury consequences, SQM disability weights might be preferable. For health outcome with dynamic or complex patterns, like mild injuries with short duration, the SQM seems to be less appropriate, since it results in relatively high disability weights that seem to overestimate the consequences.

The difference in VAS scores derived from injury patients and the population panel, with patients valuing their own health state as less severe compared, corresponds to the results found in a previous study [32]. A meta-analysis of 33 studies, however, showed that there were no significant differences between patient and non-patient preferences [33]; though it should be noted that the majority of the studies included in the meta-analysis concerned patients with chronic conditions, whereas the current study addressed injuries of mainly short duration. This disparity in duration of health consequences may have affected the patients' valuation of their own health state, since patients adapt to their health states. The effect of adaptation is especially found with chronically ill patients [34, 35]. The fact that the difference between SQM and APM disability weights is smaller for severe injuries with relatively long duration, like spinal cord injury, compared with mild injuries of short duration may also be due to adaptation to a certain health state.

Nevertheless, the present findings should be interpreted with caution because they are based on two separate datasets that did not allow a direct comparison of the data and because of the aspects mentioned earlier that may have affected the disability weights. The SQM disability weights might be considerably lower if a pre-injury baseline was used rather than a population baseline, and if the time interval to measure the health status of injury patients was more appropriate; although it is impossible to measure the health status of injury patients at the optimal time interval for the numerous consequences of injury. The values of the APM disability weights on the other hand might be higher if they were obtained from a panel of injury patients instead of a population panel, since injury patients have actually experienced the shock of accidentally sustaining an injury and the impact of its consequences on daily life.

We conclude that the approach used to assess disability weights does make a difference, and in their turn yield considerable differences in YLD calculations. The APM seems the preferred method in burden of injury studies that includes mild conditions with a rapid course, since the SQM approach yields relatively high values that may overestimate the impact of the latter. The APM on the other hand may underestimate the impact of injury consequences, especially in case of severe injuries. Nonetheless, in comparing disease burden estimates between diseases or countries differences might be attributed to the

methodological choice of disability weights applied in the DALY calculation rather than differences in incidence or prevalence.

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