

REVIEW

A systematic literature review of quality of life in lower limb amputees

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Abstract

Purpose. To systematically review studies on quality of life (QoL) in lower limb amputees.

Method. Computerised literature search of MEDLINE, CINAHL, PUBMED and PsycINFO databases was performed using the keywords, amputee, leg, knee, foot, amputation, QoL, prosthesis, orthopaedic equipment, ADL, phantom, mobility, rehabilitation, psychosocial, psychology and social. Eligible studies published from database inception through March 2009 were selected. The study was included if (1) the study population comprised of adolescent and adult lower-limb amputees as a group or a sub-group, and had ten or more subjects; (2) the study involved subjective assessment of QoL or self-appraisal of life or satisfaction with life; (3) the study was an empirical research study and (4) at least one of the study outcomes was QoL or self-appreciation of life, and QoL results were presented. The selected articles were assessed for study quality based on a standardised set of 19 criteria. The criteria list was pilot-tested for applicability and operationalisation by the authors. Objectives, study population description, QoL instruments used and study outcomes were summarised for the included studies.

Results. Twenty-six articles met the inclusion criteria. Fifteen studies were cross-sectional, four prospective, six retrospective and one mixed study-design. The studies were found to be heterogeneous with respect to the study objectives and instruments used to assess QoL. The summary quality score was 50% or more for ten studies, with the maximum being 81%.

Conclusions. Lacunas were found in the methodological and study population characteristics of most of the studies. Prospective longitudinal studies are envisaged to systematically study the events following amputation, and the change in QoL over time. To enable this, amputee specific standardised and validated QoL instruments are needed to capture the multitude of facets influencing QoL in amputees, and thereby, facilitating direct comparison across studies.

Keywords: *Amputees, lower extremity, quality of life*

Introduction

The prevalence of amputation varies country-wise. There is no up-to-date published information available about the worldwide incidence. The National Health Interview Survey 1996 (NHIS 1996) estimated that approximately 1.2 million people were living with limb loss in the United States of America [1], and 185,000 persons undergo upper or lower limb amputations each year [2]. In the Netherlands, 18–20 major lower limb amputations per 100,000 of population are performed every year [3]. In France, the incidence of lower limb amputation is estimated at 6.6 per 100,000 inhabitants per year [4].

The causes of amputation vary, and mostly depend on morbidity patterns, ageing of population, poor infrastructure, war/civil conflicts, terrorism and

natural calamities. In patients up to 60 years, trauma and cancer are the main causes of amputation [5,6]. Vascular disorders are the major contributors to lower limb amputations in western countries [3,7], whereas traumatic accidents are the major cause of amputation in developing countries [5].

Irrespective of the cause, amputation brings a dramatic change in the life situation of an individual in almost all aspects of daily living and functioning. Quality of life (QoL) of amputees gets affected due to limitations posed by body function and structure, which hinders the activity level and thereby participation, and further influenced by the environmental and personal factors as envisaged in the International Classification of Functioning, Disability and Health (ICF) framework of World Health Organisation [8]. QoL is described as a multidimensional concept [9–

11], and as an emotional and cognitive judgment about the person's well being, life satisfaction, morale, and happiness and as such may be best assessed by the person himself [12]. Therefore, a multitude of facets need to be taken into consideration to comprehensively assess QoL.

In order to gain an understanding about QoL in amputees, it's important to study the factors influencing amputees' QoL and how the different facets of QoL are measured, which determine the overall QoL in amputees. This objective will be achieved by systematically searching studies on QoL in lower limb amputees, followed by the quality assessment of included studies and summarising the study results.

Methods

Search strategy

Computerised search was performed using four databases: MEDLINE database (1966 to March 2009), CINAHL database (1982 to March 2009), EMBASE (1989 to March 2009) and PsycINFO (1972 to March 2009). The search strategy was developed taking into consideration the population under study, namely lower limb amputees and the outcome variable of interest, i.e., QoL. To include all relevant studies, not only the primary keywords namely, amputation and QoL, but also, other keywords as potential factors affecting amputees' QoL were included. The search was restricted to the citations with the keywords appearing in title, abstract or as major or minor keywords.

The Medical Search History (MeSH) terms from the thesaurus were primarily used as the keywords. The major keywords or the synonyms used for search were amputee, leg, knee, foot, amputation, QoL, prosthesis, orthopaedic equipment, ADL, phantom, mobility, rehabilitation, psychosocial, psychology and social. Further narrow keywords derived from the broad keywords were chosen from the search-database, which were also thesaurus terms, like psychosocial as the broad keyword and psychosocial factors, psychosocial readjustment as the narrow keywords, and prosthesis as the broad keyword and limb prosthesis, leg prosthesis, above-knee prosthesis and below-knee prosthesis as the narrow keywords. Combinations of keywords were made in order to refine the search results.

Selection criteria

All citations obtained were screened for relevance by one of the reviewers (RS) by studying the title and abstract of each reference. A set of exclusion criteria

were developed for this review, which were: (1) the study was published in a language other than English, (2) the study was a case-study/review/editorial/opinion papers/testimony/biography/interview/book/progress report/discussion papers/guidelines, etc., (3) the article was related to amputation but QoL was not being studied/measured, (4) the article discussed QoL from others perspective, like health care provider, care-giver, community members, (5) the study involved development or validation of QoL instrument.

Next, two reviewers (RS and WvdH) read the abstracts of the references included in the first step and critically judged them for inclusion/exclusion following the exclusion criteria. If the abstract of a particular study was not available or it was difficult to judge its relevance from the abstract, then the full article was retrieved. A study was finally included if (1) the study population comprised of adolescent and adult lower-limb amputees as a group or a subgroup, and had 10 or more amputees under study, (2) the study involved assessment of QoL, (3) the study was an empirical research study, and described methods for measures of QoL, and (4) at least one of the study outcomes was QoL or self-appreciation of life and the outcomes were presented in the results.

Quality assessment

There are no strict guidelines for methodological quality assessment of systematic reviews. Quality of a study refers to measures of internal validity, external validity and statistical criteria, i.e. whether calculations can be made and conclusions can be drawn independently to those of the original author(s) [13].

For this review, representative study population, type of study, use of standardised and validated QoL measures, appropriate statistical tests, control for confounding variables, consideration of non-response bias and data presentation of relevant outcome measures were considered as quality criteria. The criteria list for this systematic review was formulated by adopting and modifying criteria lists from other systematic reviews for observational studies [14–16]. The criteria list was pilot-tested in two steps, firstly with studies on QoL in kidney transplant patients, and secondly with a selection of studies from the list of potentially relevant articles selected for this review. Following this two-step process, the operationalisation of the criteria list got more focussed, and the definition of criteria more elaborated. Table A1 (in Appendix) describes the final quality criteria list.

Finally, two reviewers (RS and WvdH) independently assessed the quality of the included studies by scoring the studies using the standardised quality criteria list. In total, 19 criteria were used encompassing

three quality aspects: source population, study population and methodological characteristics. The scoring was solely based on the information provided in the study. The scoring discrepancies for the respective studies were discussed during consensus meetings to reach an agreement.

Results

Search results and study selection

The literature search from various databases resulted in identification of 2041 citations in total [CINAHL 508 (24.9%), EMBASE 844 (41.4%), MEDLINE 349 (17.1%), PsycINFO 340 (16.7%)]. There were 229 references, which were common in two or more of the databases leading to 1812 non-duplicate articles. After initial screening by one of the reviewers (RS), 124 out of 1812 references (6.8%) remained. Articles were excluded based on primary criteria considering the language (151), study population (661), study outcome (742), publication type (110), and instrument development or validation (24).

Next, two reviewers (RS and WvdH) applied the inclusion and exclusion criteria to the 124 references from the initial screening by reading the abstracts or the full article, if needed. Neither the abstract nor the full article could be retrieved for four references, and therefore they were excluded from the study. After following these procedures, 25 out of 120 (21%) studies got included. Studies in this step were excluded based on primary criteria considering the language (1), study population (11), study outcome (48), publication type (33), and instrument development or validation (2). One extra study was retrieved from back referencing the included 25 studies. Quality assessment scoring was done for these 26 studies. Figure 1 depicts the study eligibility flowchart.

Study quality assessment

Results of the quality assessment are presented in Table I under the categories of source population, study population and methodological characteristics, followed by a summary score. The summary quality score was 50% or more for 10 studies, with the maximum being 81%.

Study characteristics

The main characteristics of the selected studies, namely aim(s) of the study, study population, QoL assessment methodology, study outcomes and summary quality score are outlined in Table II. Ten

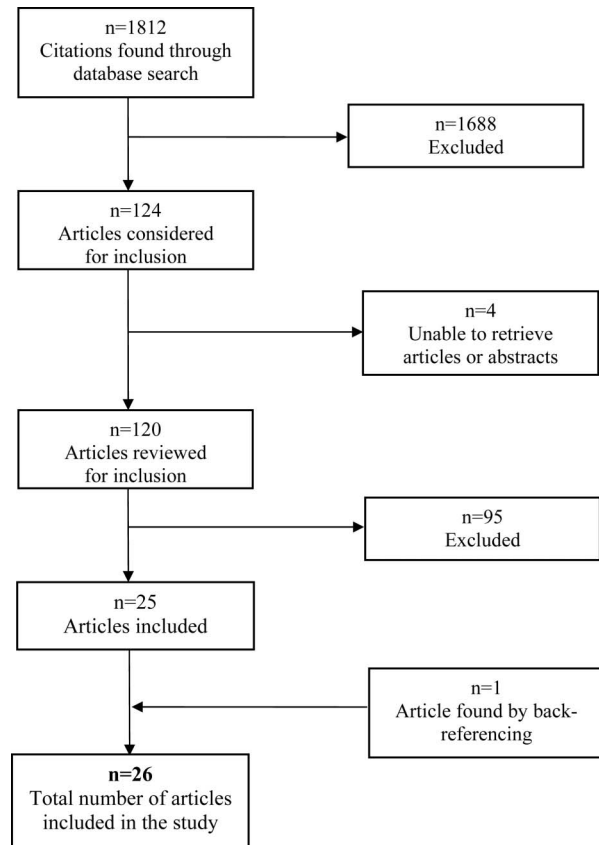


Figure 1. Study eligibility flow chart.

studies [19,20,28,31–33,35,38,40,41] were published during 1990–1999, and the remaining sixteen [17,18,21–27,29,30,34,36,37,39,42] from 2000 onwards. Thirteen [19,20,23,26,28,29,31,34–38,42] studies were focused on either critical limb ischemic or diabetic foot ulcer patients, and four [23,30,33,42] on cancer amputees.

Study population was recruited from hospitals, limb-fitting centres and amputee support organisations. QoL was measured in conjunction with other outcome variables in seven studies [23,27,30,34,36,40,42], and was also used as an outcome variable in eight studies [23,28,29,32,36–38,42] to compare different groups of amputees or interventions.

The studies have assessed QoL using quantitative measures. The generic QoL instruments used were: SF-36 in seven studies [20,23–25,27,35,36], RAND-36 in two studies [29,39], Nottingham Health Profile (NHP) in three studies [22,27,34], SIP (Sickness Impact Profile) in one study [34], WHOQOL-Bref in one study [21], EuroQoL in two studies [34,37], Prosthesis Evaluation Questionnaire (PEQ) in one study [26], visual analogue scales in four studies [17,32,37,41] and QoL ladder in one study [19]. Disease-specific QoL scales were used in three studies [18,30,42].

Table I. Results of quality assessment of included studies.

| Study | SRC POP* | | | STUD POP CHAR† | | | | | | | | | | METH CHAR‡ | | | | | | | | | | QS§ | | | |
|--|----------|---|---|----------------|---|---|---|---|---|---|---|---|----|------------|---|---|---|---|---|---|---|---|---|-----|----|----|----|
| | A | B | % | C | D | E | F | G | H | I | J | % | K | L | M | N | O | P | Q | R | S | % | % | | | | |
| Asano et al. (2008) [17] | 0 | 2 | 2 | 50 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 15 | 94 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 12 | 75 | 29 | 81 |
| Behel et al. (2002) [18] | 0 | 1 | 1 | 25 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 10 | 63 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 1 | 8 | 50 | 19 | 53 |
| Carrington et al. (1996) [19] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 7 | 44 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 6 | 38 | 15 | 42 |
| Chetter et al. (1998) [20] | 1 | 1 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 8 | 50 | 1 | 3 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 11 | 69 | 21 | 58 |
| Deans et al. (2008) [21] | 0 | 2 | 2 | 50 | 1 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 9 | 56 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 1 | 6 | 38 | 17 | 47 |
| Demet et al. (2003) [22] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 38 | 0 | 1 | 0 | 2 | 2 | 2 | 0 | 0 | 1 | 8 | 50 | 16 | 44 |
| Eiser et al. (2001) [23] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 31 | 0 | 1 | 0 | 1 | 2 | 1 | 2 | 0 | 1 | 8 | 50 | 15 | 42 |
| Hagberg and Branemark (2001) [24] | 0 | 2 | 2 | 50 | 1 | 2 | 0 | 2 | 0 | 1 | 0 | 1 | 7 | 44 | 0 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 6 | 38 | 15 | 42 |
| Hagberg et al. (2008) [25] | 2 | 2 | 4 | 100 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 2 | 7 | 44 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 15 | 94 | 26 | 72 |
| Harness and Pinzur (2001) [26] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 38 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 6 | 38 | 14 | 39 |
| Hogendoorn and Werken (2001) [27] | 1 | 2 | 3 | 75 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 31 | 1 | 2 | 0 | 2 | 1 | 0 | 2 | 0 | 1 | 9 | 56 | 17 | 47 |
| Johnson et al. (1995) [28] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 1 | 7 | 44 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 7 | 44 | 16 | 44 |
| McCutcheon et al. (2005) [29] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 8 | 50 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 1 | 6 | 38 | 16 | 44 |
| Nagarajan et al. (2004) [30] | 1 | 2 | 3 | 75 | 2 | 2 | 2 | 0 | 2 | 0 | 1 | 2 | 11 | 69 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 0 | 1 | 8 | 50 | 22 | 61 |
| Pell et al. (1993) [31] | 1 | 2 | 3 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 6 | 2 | 1 | 0 | 2 | 2 | 1 | 2 | 1 | 1 | 12 | 75 | 16 | 44 |
| Postma et al. (1992) [32] | 0 | 1 | 1 | 25 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 38 | 0 | 2 | 0 | 2 | 1 | 0 | 2 | 0 | 1 | 8 | 50 | 15 | 42 |
| Rougraff et al. (1994) [33] | 2 | 2 | 4 | 100 | 1 | 2 | 0 | 1 | 0 | 1 | 1 | 1 | 7 | 44 | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 1 | 8 | 50 | 19 | 53 |
| Spincemaille et al. (2000) [34] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 1 | 7 | 44 | 0 | 3 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 9 | 56 | 18 | 50 |
| Tangelder et al. (1999) [35] | 0 | 1 | 1 | 25 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 31 | 0 | 3 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 9 | 56 | 15 | 42 |
| Tekin et al. (2009) [36] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 38 | 0 | 2 | 1 | 2 | 2 | 1 | 2 | 0 | 1 | 11 | 69 | 19 | 53 |
| Tennvall and Apelqvist (2000) [37] | 2 | 2 | 4 | 100 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 8 | 50 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 13 | 81 | 25 | 69 |
| Thompson et al. (1995) [38] | 0 | 1 | 1 | 25 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 13 | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 6 | 38 | 9 | 25 |
| van der Schans et al. (2002) [39] | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 38 | 0 | 1 | 1 | 2 | 2 | 2 | 0 | 0 | 1 | 9 | 56 | 15 | 42 |
| Walters and Williamson (1998) [40] | 0 | 2 | 2 | 50 | 2 | 2 | 2 | 0 | 2 | 0 | 1 | 2 | 11 | 69 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 6 | 38 | 19 | 53 |
| Weiss et al. (1990) [41] | 0 | 1 | 1 | 25 | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 7 | 44 | 0 | 2 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 7 | 44 | 15 | 42 |
| Zahlten-Hinguranage et al. (2004) [42] | 0 | 2 | 2 | 50 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 31 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 6 | 38 | 13 | 36 |

Quality assessment items are labelled as listed in Table A1 in appendix (A: Source population description, B: Inclusion/exclusion description, C-I: Socio-demographic characteristics, J: Data presentation, K: Representativeness, L: Study design, M: Population selection, N: Measuring instruments, O: Statistical methods, P: Confounding variables considered, Q: Response rate, R: Characteristics of drop-outs, S: Outcome measures).

*SRC POP = Source Population.

†STUD POP CHAR = Study Population Characteristics.

‡METH CHAR = Methodological Characteristics.

§QS = Summary Quality Score.

Table II. Summary of included studies classified as per study design.

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|---|---|---|--|---|----|
| A. Cross-sectional Asano et al. (2008) [17] | Identifying factors predicting individual's subjective quality of life (QoL) after lower limb amputation | Visual Analogue Scale (VAS) | a) 415 out of 535 above-knee and below-knee amputees participated b) Patients recruited from two outpatient amputee clinics in South Western Ontario, Canada c) Mean age: 61.9 ± 15.7 years d) Avg. time since amputation: 14.5 ± 16.5 years | Depression was the most important predictor of QoL followed by perceived prosthetic mobility and social support. Other predictors of QoL were comorbidity, prosthesis problems, age and social activity participation. Less depression was associated with higher QoL. Subjects reported relatively higher QoL (7.4 ± 2.1 out of 10), which could be because subjects would initially report a reduced QoL immediately after amputation, and over-time their response may be modified due to adaptation to their situation | 81 |
| Behel et al. (2002) [18] | Examining the role of feelings of vulnerability in post-amputation adjustment problems, such as depression and diminished QOL | QOL scale – 3 item subscale from the HIV-Patient Assessed Report of Status and Experience (HIV-PARSE) | a) 84 out of 112 leg amputees participated b) Patients recruited from 5 prosthetic clinics in the Chicago Metropolitan area, USA c) Mean age: 48.4 ± 15.4 years d) Avg. time since amputation: 17 years (9 months to 49 years) | Age, gender, time since amputation, level of amputation, income and vulnerability predicted QoL. A high level of vulnerability was associated with higher levels of depression, lower QoL, and poorer overall adjustment | 53 |
| Carrington et al. (1996) [19] | Comparing the QOL between diabetic people with chronic foot ulcers or lower limb amputation and diabetic controls | Quality of life ladder, a simple unidimensional, generic scale used as a measure of life satisfaction | a) 13 diabetic unilateral lower limb amputee (DA), 13 diabetic unilateral chronic foot ulcer patients (DU) and 26 diabetic people with no history of chronic foot ulcer as controls (DC) b) Study on UK population (not explicitly reported) c) Age range: DC: 47–71 years DA: 42–72 years DU: 43–70 years d) Time since amputation: 6–18 months | The QoL ladder revealed that DU was significantly more dissatisfied with their personal lives than DC, whereas life-satisfaction of DA was mid-way between DU and DC, but was not significantly different from either group. DA and DU were significantly more depressed than DC. DU and DA had significantly poorer psychosocial adjustments to their situations than DC | 42 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|--------------------------|--|---|---|--|----|
| Deans et al. (2008) [21] | Determining the relationship between quality of life and restriction of physical activity in people with lower-limb vascular amputation | World Health Organization Quality-of-Life Scale (WHOQOL-Bref) | <ul style="list-style-type: none"> a) 25 out of 75 trans-tibial or trans-femoral unilateral amputees due to peripheral vascular disease participated b) Patients recruited from Glasgow-based rehabilitation and mobility centre based in UK c) There were 5 trans-tibial amputees ≤ 60 years, 17 > 60 years; and 3 trans-femoral amputees > 60 years d) Time since amputation: > 2 years | Physical domain of QoL was the most affected and environmental domain was the least affected. Amputees gave higher importance on social standing and friendships with family and friends than on physical ability | 47 |
| Demet et al. (2003) [22] | Assessing the nature of factors related to health related quality of life (HRQL) of persons with limb amputation | Part 1 of Nottingham Health Profile (NHP) | <ul style="list-style-type: none"> a) 539 out of 1011 potential respondents with major upper and lower limb amputations b) Patients recruited from Nancy Region Prosthesis Centre of War Victims in eastern France c) Mean age: 66.1 ± 14.1 years d) Mean age at the time of amputation: 29.9 ± 20.2 years | Young age at the time of amputation and traumatic origin were associated with better HRQL. Men had better HRQL than women in domains of physical disability, energy level, emotional reactions and social isolation. Young age was also associated with better HRQL in all these domains. Vascular amputees had greater physical disability and greater social isolation | 44 |
| Eiser et al. (2001) [23] | Investigating QoL, body image and daily competence of patients as a consequence of limb salvage surgery (LSS), primary or secondary amputation, and views of patients following secondary amputation | SF-36 Health Survey | <ul style="list-style-type: none"> a) 34 out of 37 patients free of disease and one year post-primary or secondary amputation due to osteosarcoma or Ewing's sarcoma. Semi-structured interview was done in 10 of 11 patients undergoing secondary amputation b) Patients recruited from the Royal orthopaedics hospital, Birmingham, UK | Regardless of surgery, patients' treated for a bone tumour report poorer QoL than expected population norms, except in emotional functioning and mental health. Men reported better physical functioning than woman. Better body image and everyday competence were associated with greater QoL. No difference in QoL in Amputation <i>vs.</i> LSS group, | 42 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|--------------------------------|--|---|---|--|----|
| | | | <ul style="list-style-type: none"> c) Median age for Primary amputation, LSS and Secondary amputation groups were 32, 30 and 32.5 years respectively d) Time since amputation: Not reported | <p>however LSS reported better daily competence and were less likely to use a walking aid. LSS group report better everyday competence than amputees. Patients who accept responsibility for the decision to amputate tend to be more satisfied and better adjusted</p> | |
| Harness and Pinzur (2001) [26] | Obtaining health related QOL (HRQOL) data in patients with non-traumatic transtibial amputations, and who were successful prosthetic users | Linear analogue Prosthetic Evaluation Questionnaire (PEQ) | <ul style="list-style-type: none"> a) 60 adults selected with unilateral non-traumatic transtibial amputation, because of diabetes or peripheral vascular disease b) Patients recruited from Loyola Orthopaedic Clinic, the Edward R. Hines Veterans Hospital amputee clinic, and two local prosthetic limb companies based in USA c) Mean age: 65.9 ± 1.4; Median age: 68 d) Avg. time using prosthesis: 38.1 ± 4.7 months | <p>Patients' overall perception of their function, mobility, psychosocial response, overall well-being and satisfaction were favourable. Patients' perception of their overall HRQOL was different from the predictions of experts, as patients scored reasonably well in overall well-being as compared to mobility</p> | 39 |
| Johnson et al. (1995) [28] | Studying the QoL of amputees and revascularization and limb salvage (RLS) patients for critical limb ischemia at 6 months after initial intervention | Six separate QoL measures of pain (Burford thermometer, a visual analogue scale), mobility (graded scale from total immobility to unlimited ambulation), the Hospital Anxiety and Depression scale, the Barthel independent ADL index and the Frenchay activities index for lifestyle | <ul style="list-style-type: none"> a) 47 out of 79 patients who had either a successful revascularization or a major amputation, and who were alive, participated b) Patients recruited from Royal Hallamshire Hospital, UK c) Median age: 75 years d) Time since amputation: 6 months | <p>RLS resulted in greater mobility and better performance in self-care and lifestyle, but produced more anxiety and depression than major amputation. Overall amputation was more costly than successful revascularization and limb salvage. Patients who had major amputation after failed limb salvage had mobility similar to amputees, and self-care and lifestyle similar to limb salvage patients</p> | 44 |
| McCutcheon et al. (2005) [29] | Comparing the QoL of persons who have experienced amputations, and persons who have had bowel resections | RAND 36-Item Health Survey | <ul style="list-style-type: none"> a) 28 out of 150 Crohn disease (CD) and resected patients, and 16 out of 150 Peripheral vascular amputation (PVA) patients | <p>PVA subjects had a lower overall level of QoL in all domains, and had an average score only in domains of pain, emotional well-being, social functioning, and</p> | 44 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|------------------------------|--|-----------------------------------|---|---|----|
| | | | <ul style="list-style-type: none"> b) Practices of various general surgeons, gastroenterologists and orthopaedic surgeons based in USA c) Mean age: CD: 45.5 years PVA: 62.2 years d) Time since amputation: Not reported | role limitation caused by emotional health. Social functioning, emotional well-being, and role limitations caused by emotional problems were areas in which PVA and CD patients experienced post-operative impairment | |
| Nagarajan et al. (2004) [30] | Assessing self-reported function and QoL among long-term survivors of childhood lower extremity bone tumours | QoL for Cancer Survivors (QoL-CS) | <ul style="list-style-type: none"> a) 528 out of 629 adult long term survivors of paediatric lower extremity bone tumours participated b) Recruitment source not explicitly reported c) Mean age: 34.8 years d) Average years from diagnosis to questionnaire completion: 20.8 | Overall survivors reported excellent QoL and functioning. Amputees were not more likely to have lower function and QoL as compared to limb sparing procedure. Females reported significantly lower QoL, but not more disability. Being female, lower education and older current age had a negative influence on QoL, function and disability. Self-perception of disability was affected by general health status, lower education, older age and being female | 61 |
| Pell et al. (1993) [31] | Assessing the overall effect of amputation on quality of life, including psycho-social functioning as well as mobility, and measures of the extent to which outcomes are inter-related | Nottingham Health Profile (NHP) | <ul style="list-style-type: none"> a) 149 alive patients out of 648 major lower limb amputees b) Patients recruited from Edinburgh Royal Infirmary, and age and sex matched control group selected from the register of a general practice in Lothian, UK c) Median age: 73 years d) Median time since last amputation: 38 months | Amputees had significantly more problems in all domains of QoL such as mobility, social isolation, energy, pain, sleep and emotional disturbance than controls; however mobility was the only outcome for which the difference between the two groups remained significant after stepwise logistic regression. Overall QoL following amputation for peripheral | 44 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|--|---|---|--|--|----|
| van der Schans et al. (2002) [39] | Describing health-related QoL in lower limb amputees and investigating potential determinants, including phantom pain | RAND-36 Dutch Language Version | a) 437 out of 1436 lower limb amputees b) Patients recruited from an orthopaedic workshop database in The Netherlands c) Mean age: 65 ± 15 years d) Time since amputation, median (min–max): 10 (1–80) years | arterial disease was poor, but much of it is secondary to restricted mobility Amputees with phantom pain had a poorer health-related QoL than amputees without phantom pain. The most important amputation-specific determinants of health-related QoL were walking distance and stump pain | 42 |
| Tennvall and Apelqvist (2000) [37] | Investigating health-related quality of life (HRQL) in diabetes patients with foot ulcers (FU), primary healed ulcers (PHU), or those with minor (MIA) or major amputations (MAA) | EuroQoL (EQ-5D) including a visual analogue scale (VAS) | a) 310 out of 440 patients participated b) Patients recruited from Lund University Hospital, Sweden c) Mean age: 67 years d) Time since amputation: Not reported | MIA patients had better HRQL than FU with no previous amputation. MAA had lower HRQL than PHU with no amputation and MIA. VAS value was reduced in MAA due to diabetic complications, and increased by living with a healthy partner. QoL was reduced after MAA | 69 |
| Walters and Williamson (1998) [40] | Investigating predictors of sexual satisfaction, experience with pain, and perceived QoL Assessing associations between sexual satisfaction and several measures of physical and psychological adjustment, and that among sexual satisfaction, amputation-related pain and QoL | Participants described their QoL as compared to before amputation on a five-point scale | a) 77 patients participated (number of prospective participants not reported) b) Patients recruited from an out-patient amputee clinic and amputee support organizations based in USA c) Mean age: 57 years d) Average time since amputation: 14.5 years | Higher education or professional training was associated with higher QoL. More sexual satisfaction was related to higher QoL. More amputation related pain was associated with less sexual satisfaction and lower QoL. Amputation related pain independently predicted QoL | 53 |
| Zahlten-Hinguranage et al. (2004) [42] | Assessing potential difference in treatment outcome between amputation and limb salvage surgery (LSS) by investigating QoL and function | Disease specific QoL- Standard German version of EORTC QLQ-C30 Generic QoL-FLZ Life Satisfaction Questionnaire | a) 102 LSS patients and 22 amputees, out of 189 eligible survivors of a malignant lower extremity sarcoma b) Patients recruited from Orthopaedic University Clinic Heidelberg, Germany c) Median age: LSS: 33 years Amputees: 37 years d) Average time since surgery: 5 years | Similar QoL in amputees and LSS groups. Amputees' associated QoL with social acceptability, while LSS associated it with higher physical performance in sports and recreational activities | 36 |

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|---|---|--|--|---|----|
| B. Prospective Chetter et al. (1998) [20] | Analyzing the health-related QoL changes associated with infrainguinal arterial reconstruction for chronic critical limb ischemia, and to assess the impact of graft patency and limb salvage | UK version of SF-36 health survey questionnaire, completed before and at 1, 3, 6 and 12 months following surgery | a) 55 out of 65 patients participated b) Recruitment centre not explicitly reported c) Median age: 71 years d) Time since surgery: Not reported | Patients with critical limb ischemia had severely impaired QoL. Reconstruction had significant improvements in Physical Functioning, Pain, Vitality and Social Functioning, and with a patent graft these improvements began soon after surgery and maintained for 12 months. Irredeemable graft occlusion patients who had secondary amputation reported moderate QoL improvements | 58 |
| Hagberg et al. (2008) [25] | Analyzing general and condition-specific health related quality of life (HRQL) at 2-year follow-up as compared to the pre-operative situation | SF-36 administered pre-operatively and at follow-up, and Q-TFA (Questionnaire for persons with a Transfemoral Amputation), a condition-specific outcome measure that reflects current prosthetic use, mobility, problems and global health | a) 17 out of 18 consecutive patients participated, and who were treated with either a surgery involving titanium implant inserted in the residual bone and left unloaded for about six months or a surgery involving titanium rod inserted into the distal end of the fixture and then penetrating the skin b) Patients recruited from University hospital in Sweden c) Mean age: 45 years d) Average time since amputation: 15 years | General physical HRQL (Physical Functioning, Role Physical, Bodily Pain), PCS (Physical Component Summary) score and Q-TFA (Prosthetic Use, Prosthetic Mobility, Problems and Global Health) significantly improved at 2-year follow-up | 72 |
| Spincemaille et al. (2000) [34] | Assessment of pain and quality of life of patients with critical limb ischemia at follow-up | NHP, EuroQoL and mobility subscore of Sickness Impact Profile (SIP) administered at intake, and at 1, 3, 6, 12 and 18 months | a) 120 out of 141 patients participated, out of which 60 had standard treatment (ST) and 60 had standard treatment combined with spinal cord stimulation (SCS) b) Patients recruited from 17 hospitals in The Netherlands c) Mean age: ST: 72 ± 10.6 SCS: 73 ± 9.8 d) Time since surgery: Not reported | Overall QoL improved significantly in both the groups, but with no difference between groups. Amputation had a negative effect on mobility, resulting in difficult rehabilitation but relieved pain substantially | 50 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|---|--|--|---|---|----|
| Tangelder et al. (1999) [35] | Comparing QoL in patients, with and without various ischemic complications after infrainguinal bypass grafting surgery for occlusive vascular disease | EuroQoL and SF-36 was administered every half year from November 1995 until April 1998 | a) 682 of 746 patients (patent graft = 409, asymptomatic occlusion = 32, symptomatic occlusion = 65, revascularization = 194, primary amputation = 36 and secondary amputation = 38) participated and completed the questionnaire b) Subjects recruited from Dutch BOA (Bypass, Oral Anticoagulant and Aspirin) multi-centre study c) Mean age of 746 patients: 70 years d) Time since surgery: Not reported | Amputation deteriorated physical functioning and more so after failed secondary revascularization. Social functioning, physical and emotional role, and mental health were poorer than all other groups. QoL deteriorated after all events, except for asymptomatic occlusions. QoL was constant over time in all the groups in the observed period | 42 |
| C. Retrospective Hagberg and Branemark (2001) [24] | Describing HRQL (Health-related quality-of-life), prosthetic use and problems in individuals with unilateral trans-femoral amputation from non-peripheral vascular disease | Swedish SF-36 Health Survey | a) 97 out of 140 non-vascular trans-femoral amputees b) Patients recruited from two Swedish associations for amputees and six orthopaedic workshops and/or walking school units c) Mean age: 48 years d) Average time since amputation: 22 years | General HRQL was significantly lower than Swedish age- and gender-matched norms in all eight dimensions, and there were considerable problems with amputation and prosthesis. Problems that led to reduction in QoL were heat/sweating in prosthetic socket, sores/skin irritation from socket, inability to walk in woods and fields and inability to walk quickly. Almost half amputees were troubled by stump pain, phantom limb pain, back pain and pain in the other leg | 42 |
| Postma et al. (1992) [32] | Comparing long- term QOL in limb salvage (LS) vs. amputees (AMP) in lower limb bone tumour patients | Hopkins Symptom Checklist (HSCL) Groningen Activity Restriction Scale (GARS) Rosenberg self esteem scale (short version) | a) 14 LS and 19 AMP out of 36 patients b) Recruitment source not explicitly reported c) Median age: LS: 24 years AMP: 27 years d) Median time since amputation: 10 years | Although QoL was similar in both the groups, both the groups felt diminution of QoL as well as a sense of disability. No significant difference between both the groups in psychological and physical distress, activities of daily living and self-esteem, nor were they different from normal | 42 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|-----------------------------|--|---|--|--|----|
| | | Semi-structured interview comprising educational and vocational impact of treatment, marital status, possibility to move independently, some aspects of costs of living, and participation in social life. Subjects were asked to comment on psychological impact of treatment | | | |
| | | Visual analogue scale (VAS) to assess satisfaction on quality of life and individual perception of being disabled | | | |
| Rougraff et al. (1994) [33] | Studying the outcome of treatment of non-metastatic high-grade osteosarcoma in the distal part of femur | Brief symptom inventory for a psychopathological evaluation, the psychosocial adjustment to illness scale, the Melzack pain questionnaire, demographics, fertility and sexual function. Subjective rating of physical function; change of satisfaction with life ranked from -10 to +10 and that of appreciation of life, from 0 to +10 | a) 29 of 109 patients completed the psychosocial (QoL) questionnaire b) Patients from multi-institutional Musculoskeletal Tumour Society study conducted in USA c) Mean age at diagnosis: 16 years d) Average duration of follow-up: 11 years | Function was better in LSS than AMP, however it did not provide a measurable benefit in QoL. No difference between groups with regard to patient's acceptance of the postoperative state, ability to walk, or the amount of pain. No difference in psychosocial outcomes between the groups. Scores on brief symptom inventory and psychosocial adjustment to illness scale were generally within the norms of the general population. No difference in life appreciation before and after cancer. No significant differences between the three groups based on QoL data | 53 |
| Tekin et al. (2009) [36] | Comparing functionality in daily activities and quality of life in transtibial amputees and limb salvage surgery patients after severe lower limb trauma | SF-36 (Turkish validated version) | a) 10 and 9 young male soldiers with unilateral below knee amputation and with salvage surgery respectively b) Turkish Armed Forces Rehabilitation Centre c) Mean age: Amputees - 27.70 ± 5.31 and salvage patients - 28.44 ± 4.21 | Overall QoL (general health and vitality being significantly better), reoperation rates and pain was better in amputees than limb sparing surgery | 53 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|-----------------------------|---|--|---|--|----|
| Thompson et al. (1995) [38] | Assessing QoL after femorodistal bypass (FB), and comparing it with QoL following primary lower limb amputation (LLA) | Hospital anxiety and depression scale Social functioning: impairment of work, family relationships, social activities, leisure activities and home management Patient mobility and use of walking aid from unrestricted walking to independent walking | d) Average duration of injury: Amputees- 50.30 ± 54.18 and salvage- 66.11 ± 49.58 a) 82 out of 112 patients participated, 31 patients primary patent graft; 17 secondary patent graft; 7 secondary amputation and 17 primary amputation b) Patients recruited from Leicester Royal Infirmary, UK c) Median age: 69 years d) Median time since amputation and reconstruction were 16 and 18 months | QoL after successful FB is higher than after primary or secondary LLA. Patients with patent grafts had lower impairment of QoL than patients undergoing primary or secondary amputation. A secondary procedure to maintain graft patency did not adversely affect QoL. Additionally, patients undergoing secondary amputation after graft failure had an identical QoL to those undergoing primary amputation | 25 |
| Weiss et al. (1990) [41] | Identifying factors that predict outcomes, including postoperative complications, stump revision, mortality, and poor QoL | A question asking the patient to rate his/her health as excellent, good, fair, or poor and the Affect Balance Scale (assesses the degree to which positive feelings about life outweigh negative feelings. Another question rated QoL on a visual analogue scale | a) 97 patients who underwent either lower extremity amputation, revision, secondary closure, or debridement b) Patients recruited from John L. McClellan Memorial Veterans Hospital, Arkansas, USA c) Median age: 64 years d) Average time since surgery: 15 months | Amputees' QoL was fairly poor compared with older persons. 29% reported better health at follow-up than before amputation, primarily because of less pain, one-quarter reported worse health, and majority rated their health either fair or poor. Ability to perform activities of daily living (ADL) was the most important predictor for self-perceived health, well-being (Affect Balance), and QoL. Poor health status was best predicted by dependency in ADL, high level of amputation and older age. Negative feelings were predominately affected by dependency in ADL and diabetes | 42 |

(continued)

Table II. (Continued).

| Study | Aim of study | QoL assessment | Study population description | Study outcomes | QS |
|--|--|---|---|---|----|
| D. Mixed Design Hoogendoorn and Werken (2001) [27] | Assessing the long-term functional outcome and QoL of patients who were treated for Grade 3 open tibial fracture | Nottingham Health Profile (NHP), SF-36 and one questionnaire designed for the study, which consisted of questions related to pain, daily functioning, psychological factors and handicap with working | a) 64 out of 72 patients comprising of 43 successful limb salvage (LS) patients and 21 amputees b) Patients recruited from Utrecht University Medical centre, The Netherlands c) Mean age: LS: 39.9 ± 16.2 Amputees: 39.4 ± 15.9 d) Time since surgery: not reported | LS and amputees had a worse QoL in most categories than a healthy reference group. 65% patients reported problems with walking, due to fatigue, pain and shortness of breath. 48% patients feel disabled, as they were not able to do everything as before accident. 45% reported problems with working | 47 |

QoL findings

Amputees' QoL was found to be mostly poor compared to the general population or controls [23,24,27,30,31,41]. Women reported worse QoL than men [22,23,26]. Age was an important predictor of QoL [17,22,30], and so was education [30,40].

QoL was adversely affected by phantom and stump pain [39,40], and depression [17,18]. Limitation in physical functioning affected QoL to a great extent [21,22,31,35,39], and it affected vascular amputees more negatively [22]. ADL [41] and sexual satisfaction [40] were found to be important factors affecting QoL. Low social acceptance and low social functioning also affected QoL adversely [35,40].

Discussions

Study identification

The search strategy adopted for the systematic search was exhaustive, since several keywords associated with 'amputees' and 'QoL' available in different databases were used. Back-referencing of the included articles led to inclusion of only one extra article, which indicates comprehensiveness of search strategy. A limitation of this systematic search is that only articles published in English language were considered for inclusion. The number of non-English articles during the initial search was 151 (8.33%) out of 1812 references. Generally, methodologically sound studies tend to get published in English language, and thereby perhaps lowering the possibility of high quality studies getting excluded because of the possible language bias.

During the screening process, it was noticed that QoL as a term was loosely used in many studies in the articles, and it also appeared as a keyword in several citations, even though the study did not involve assessment of QoL. We included studies in which QoL was the outcome variable, so it might be possible that studies which have used QoL instrument, but to study outcomes other than QoL would have got excluded from this review.

Study design

The systematic review revealed a lack of longitudinal prospective studies, and therefore, evidence-base about the change in QoL of amputees over time as a result of the immediate changed life situation and adjustments following amputation is inadequate. The few prospective studies found mainly assessed the outcomes of intervention in critical limb ischemic patients [20,34,35].

Representativeness of study population might be an issue for most of the studies, as the characteristics of the source population from which the study population was derived, were not presented. So, the chance of selection bias cannot be totally disregarded. Especially, for studies in which the patients have been recruited from orthopaedic workshops and rehabilitation centres [18,21,22,24,39,40], a selective group of amputees who were interested in rehabilitation, and who would be using prosthesis might have participated. Studies recruiting patients from primary sources, like hospitals and clinics would have better external validity and enable the generalisation of the results. Sample size and power calculations have been performed only in one study [34]. Therefore, results of other studies need to be interpreted with care.

Background information and QoL

Although the studies provided information about the age and gender characteristics of the study population, QoL variation across different age groups and gender has mostly not been reported. Because of relatively lower representation of females in the study population, their QoL comparison with males has to be judged with care.

Most of the studies lacked information about background variables, like education, employment, economic, civil status and co-morbidity, which limit the QoL analysis in a holistic manner, as these factors also play an important role in determining QoL. The effect of these variables as well as amputation and limb-related variables should be studied. Other data, for example, number of failed reconstructions, number of amputations and duration between these, duration of hospitalisation, number of visits to hospitals/clinics or utilisation of paramedical care, etc. and the effect of these factors on QoL should be studied.

The number of QoL studies was relatively low for amputees who were victims of accidents or war. Disease was found to be the most frequent reason for amputation except two studies [22,36].

Methodological quality

Seven studies had response rate equal to or more than 80%. Characteristics of non-respondents have been reported in only four studies. Since many background variables were not included in the studies and the confounding variables have only been considered partially in some studies; therefore, the study results need to be interpreted with care.

QoL measures

A general health-related QoL and/or combination of questionnaires have generally been used to measure QoL. The variation in QoL instruments in the studies is large, which hinders a systematic comparison of outcomes. Although a generic QoL instrument comprises of several multi-dimensional facets, it still might not be able to capture specific issues relevant to amputees. Asano et al. [17] and Johnson et al. [28] used a combination of different instruments to study QoL.

Environmental factors, like family condition, family support, life situation before amputation, etc. determine outcomes after amputation, but the influence of these factors on QoL has been assessed only by a few studies. It is envisaged that QoL of amputees should be studied using the ICF framework [8] and including all the pertinent facets, such as amputation-related, personal and environmental factors, which might affect QoL directly or indirectly.

To conclude, very few methodologically sound studies were found in this systematic review, which limits the generalisation of the findings. Prospective longitudinal studies are envisaged to systematically study the events following amputation, and the change in QoL over time. To enable this, amputee specific standardised and validated QoL instruments are needed to capture the multitude of facets influencing QoL in amputees, and which would make assessment of QoL easier, comprehensive and useful in clinical practise, and enable effective decision making. Additionally, qualitative studies are encouraged to garner insights to complement the quantitative findings.

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Appendix

Table A1. Quality criteria list.

| Criteria | Scores |
|--|---|
| Source population | |
| A Description of source population | Not available (0), Ambiguous (1), Available (2) |
| B Description of inclusion and/or exclusion criteria | |
| Study population characteristics | |
| C Age | Not available (0), Partially available (1), Available (2) |
| D Gender | |
| E Education | |
| F Employment status | |
| G Marital status | |
| H Comorbidity | |
| I Economic status | |
| J Data presentation of relevant outcome measures | |
| Methodological characteristics | |
| K Representative population | Not clear (0), Partially (1), Yes (2) |
| L Study design/study type | Not clear (0), Cross sectional design (1), Retrospective/Mixed design (2), Prospective design (3) |
| M Population selection | Non randomized (0), Randomized / NA (1) |
| N Instruments used | Non-validated (0), Partially validated (1), Validated (2) |
| O Statistical methods for measures | Non-appropriate (0), Partially appropriate (1), Appropriate (2) |
| P Control for confounding variables | Not considered (0), Partially considered (1), Fully considered (2) |
| Q Response rate vs. drop out | < 60% / Not mentioned (0), 60% - 80% (1), > 80% (2) |
| R Characteristics of drop-outs | Not reported (0), Reported (1) |
| S Relevant outcome measures | Not well-defined (0), Well-defined (1) |