Return to work after acquired brain injury
van Velzen, Judith

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Chapter 2:

How many people return to work after acquired brain injury?: a systematic review

Abstract

**Primary objective:** To investigate how many people return to work (RTW) after acquiring brain injury (ABI) due to traumatic or non-traumatic causes. Secondary objectives were to investigate the differences in outcome between traumatic and non-traumatic causes, the development of RTW over time, and whether or not people return to their former job.

**Methods:** A systematic literature search (1992-2008) was performed using terms of ABI and RTW. The methodological quality of the studies was determined. An overall estimation of percentage RTW 1 and 2 years post-injury was calculated by data pooling.

**Main outcomes and results:** Finally, 49 studies were included. Within 2 years post-injury, 39.3% of the subjects with non-traumatic ABI returned to work. Among people with traumatic ABI, 40.7% returned to work after 1 year and 40.8% after 2 years. No effect of cause or time since injury was found. Some people with traumatic ABI who returned to work were not able to sustain their job over time. Changes of occupation and job demands are common among people with ABI.

**Conclusions:** About 40% of the people with traumatic or non-traumatic ABI are able to return to work after 1 or 2 years. Among those with acquired traumatic brain injury a substantial proportion of the subjects were either not able to return to their former work or unable to return permanently.
Introduction

In the Netherlands, 60,000 people a year or 400 of every 100,000 citizens are registered in the hospitals due to acquired brain injury. Of these, an estimated 15,000 brain injuries result from traumatic causes and an estimated 45,000 from non-traumatic causes. Most people with traumatic brain injury are of working age and about 30% of the people with non-traumatic brain injury are under 65 years of age. It is expected therefore that most people were working before acquiring brain injury. Although traumatic and non-traumatic brain injury are both considered forms of acquired brain injury (ABI), the impacts on functioning and as a result on participation like employment can vary. To investigate and compare the effects of both types of ABI on employment would be interesting therefore.

Employment is a part of participation that influences different aspects of life, also for people with ABI. People with ABI who are employed report an improved sense of wellbeing, better health status, greater social integration within the community, less usage of health services, more social contacts, and a better quality-of-life than people who are not employed. Being employed is therefore an important part of life. However, ABI is known as one of the most disabling diseases, affecting neurological, psychiatric, and cognitive functions and making return to work (RTW) difficult. According to the literature review of Shames et al., 13-70% of the people with traumatic brain injury return to work between 6 weeks and 7 years post-injury. Treger et al. reported in their review that 19-73% of people with a stroke return to work. The variability in RTW numbers could possibly be caused by different definitions of RTW used in the studies. In some studies taking care of the household or studying was defined as working, whereas in other studies only paid work was included. This discrepancy makes it difficult to compare the results of the different studies and to draw valid conclusions, moreover because the existing overviews were not systematically performed, lacking a clear search strategy or inclusion criteria for example. The purpose of the current study was, therefore, to provide a systematic overview of the number of people returning to work after acquiring brain injury. This study sought to determine not only whether people with ABI are able to return to work at a certain moment of time, but also how RTW progresses over time, if RTW is permanent, and whether people return to their former jobs. Since RTW levels would be different for people with or without work before ABI, it was decided to focus on people who were working in a paid or volunteer job before ABI. In summary, the main research question of this review is: how many people with traumatic or non-traumatic ABI return to work? Secondary research questions that were explored in the acquired articles were a) are there differences in percentage RTW between people with traumatic versus non-traumatic ABI?; b) how does RTW develop over time?; and c) do people return to their former jobs?
Methods

Literature search
An overview of the number of people who return to work after ABI was provided by performing a systematic literature search in the Pubmed, EMBASE, CINAHL, and PsycINFO databases. The search strategy consisted of several terms denoting brain injury and return to work (Appendix). Keywords were adapted to the particularities of the various databases. Where possible, existing Medical Subject Headings (or MeSH terms) were used. Limitations were set on language (English, Dutch, and German) and publication date (01 January 1992 to 31 July 2008). For PsycINFO, document type was also limited (journal-article and publication-information). Secondary research questions were explored in the research articles found according to the abovementioned search strategy.

Study inclusion criteria
Studies were selected manually by screening the titles and abstracts for relevance based on the following criteria of inclusion: a) the study concerned people with non-progressive acquired brain injury, b) (return to) work or participation was mentioned in the title of the study, and c) the study included adults. All studies that were selected for full review after this screening were selected based on the criteria: a) return to work was an outcome measure, b) people were working before ABI occurred, and c) age of the subjects was between 18 and 65 years old. Selection and reviewing were performed by one author (JvV). In cases of uncertainty, two other authors (MF and JS) were consulted to reach consensus.

Methodological quality assessment
Methodological quality of all studies that were finally included was scored. Because no existing list encompasses the factors of interest, the ‘checklist for statistical review of general papers’ by Gardner & Altman was adapted based on experience (Table 1). The list consisted of five criteria: for each criterion that was fulfilled 1 point was earned, leading to a score between 0 and 5 points.

Data extraction
After full review and assessment of methodological quality, the following data were extracted to answer the research question: reference, country, demographic data (total number of subjects, age (mean and range), and gender), clinical data (injury and severity of injury), follow-up time, the methods used to determine RTW, and percentage RTW (Table 2, 3, and 4). Additionally the score of the methodological quality was described in the tables. In order to be able to compare the different studies it was chosen to register the data as described above. In case the data were not described in the original
How many people return to work after acquired brain injury?

Table 1: Methodological quality list (adapted from Gardner & Altman15)

<table>
<thead>
<tr>
<th>Criteria of methodological quality*</th>
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</thead>
<tbody>
<tr>
<td>Study population</td>
</tr>
<tr>
<td>1. Demographic information (such as age and gender) was given</td>
</tr>
<tr>
<td>2. Clinical information (such as cause and severity of brain injury) was given</td>
</tr>
<tr>
<td>3. Brain injury was classified according to a known classification</td>
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<tr>
<td>4. Duration of follow-up was described</td>
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<tr>
<td>Outcome</td>
</tr>
<tr>
<td>5. Quality of the instruments used to measure RTW was known</td>
</tr>
</tbody>
</table>

*Study scored 1 point for each criterion that was fulfilled, yielding a score between 0 and 5 points

publication as was chosen in the current study or if the methods used to determine RTW were unclear, a question mark was registered in tables 2, 3, and 4 to specify that the specific value is unknown or unclear.

Data pooling
In order to get an overall estimate of the percentage of RTW, the results of the studies were pooled when possible. All studies with a more or less comparable design (same follow-up time and injury severity) and a relatively high methodological quality (score 4 or 5) were included. The exact criteria were chosen based on the availability of the studies, needing more than one study to be able to pool. For the pooling of data, the total number of subjects who participated in the studies and the total number of subjects that returned to work were counted. Based on these numbers, the overall RTW percentage was estimated.

Results

Search strategy
The search process provided a total of 2233 references after excluding the double references that appeared more than once because they were found in more than one database (Figure 1). After checking the titles and abstracts for relevance, 209 studies were included for full review, of which 49 studies fulfilled all criteria of inclusion. Notably, most studies were excluded because members of the study population were not working before ABI or because the definition of RTW did not match the definition used in the current study, including studying for example.
Methodological quality
The methodological quality of the included studies is shown in tables 2, 3, and 4. Overall, one study scored 1 point, seven studies scored 2 points, eight studies scored 3 points, 30 studies scored 4 points, and three studies scored the maximum of 5 points. The main reasons for sub-maximal scores were unknown quality of the instruments used to measure RTW and not using a known classification of brain injury.

Number of people returning to work
The criteria to be included into the pooling were determined as having a follow-up time of either 1 or 2 years and including a wide range of patients with respect to injury severity, varying from mild to severe ABI. Because no clear definition of injury severity after stroke was available, all studies with a follow-up time of 1 or 2 years were included. The results for non-traumatic and traumatic ABI are hereafter described separately before combining them.

Non-traumatic brain injury
In table 2 the results of 12 studies investigating the number of people returning to work after ABI by non-traumatic causes are presented. In people with ABI caused by stroke, the RTW percentage varied between 2.6% and 59.5% in the nine studies included. Hartman et al.\textsuperscript{16} reported 2.6%, an outlier compared to the results of the other studies (four studies reported about 40% RTW and four studies about 55% RTW). Excluding the study of Hartman et al.\textsuperscript{16}, RTW varied between 35.4% and 59.5%. For the pooling of the data at 1 year follow-up, only the study of Wozniak et al.\textsuperscript{17} remained after excluding the
How many people return to work after acquired brain injury?

study of Hartman et al.\textsuperscript{16} Therefore no overall estimation was possible for 1 year follow-up. The studies of Wozniak et al.\textsuperscript{17} and Vestling et al.\textsuperscript{18} fulfilled the criteria at 2 years follow-up, leading to an estimation of 39.3% RTW.

Three studies were found in which the return to work of people with ABI caused by subarachnoid haemorrhage (SAH) was studied. Return to work varied between 37.5% and 71.5%. Yap and Chua\textsuperscript{19} reported 37.5% RTW whereas in the other two studies\textsuperscript{20,21} about 65% RTW was found. The small sample size and the follow-up time of only 6 months in the study of Yap and Chua\textsuperscript{19} likely explain this difference. Because only one study had a follow-up time of 1 year, no average percentage RTW could be calculated. However, when stroke and SAH were taken together as non-traumatic causes, an overall estimate of 64.8% RTW was found 1 year after ABI, based on results from the studies of Wozniak et al.\textsuperscript{17} and Nishino et al.\textsuperscript{21}, including 302 subjects.

\textbf{Traumatic brain injury}

Thirty-five studies were found for people who acquired brain injury by traumatic causes (Table 3). RTW varied between 0% and 84%. In the studies of Dikmen et al.\textsuperscript{28}, Bounds et al.\textsuperscript{29}, and Ruff et al.\textsuperscript{30} low numbers of RTW were found, 0%, 18%, and 17.9%, respectively. However, in the studies of Dikmen et al.\textsuperscript{28} and Ruff et al.\textsuperscript{30} only people with a severe brain injury were included (examining only 1 and 6 months post-injury, respectively). The results of the review of Shames et al.\textsuperscript{11} suggest that injury severity could influence RTW. Bounds et al.\textsuperscript{29} included subjects after 9.2 years mean time since injury with a range between 2 months and 41 years; injury severity of the subjects participating in this study remained unclear. Grosswasser et al.\textsuperscript{31} also determined RTW a long time after injury (12-14 years) and found 84% RTW in people with closed head injury. However, most of the subjects participating in this study had a mild to moderate ABI. In the study of Hanlon et al.\textsuperscript{32}, 78% of the participating subjects were able to return to work within 1 year; those subjects all had a mild traumatic brain injury. After excluding the outliers with very high or very low percentages of RTW as described above, 30%-65% RTW was found. The overall estimate of the percentage RTW 1 year after injury was determined for the 4709 subjects of six studies\textsuperscript{33-38}, leading to an overall estimate of 40.7% RTW. An overall estimate of 40.8% RTW was found at 2 years after injury based on 276 subjects from three studies.\textsuperscript{35,39,40}

Both non-traumatic and traumatic brain injury

Three studies included people with ABI by traumatic or non-traumatic causes without reporting the results for each cause separately (Table 4). In these studies 46.8-69.3% RTW was found. Because there was no study that fulfilled all the inclusion criteria, it was not possible to pool the data and obtain an average estimate.
Table 2: Results of the review concerning people with non-traumatic brain injury, ordered by time since injury and separated into stroke and subarachnoid haemorrhage (SAH). A question mark was registered if the variable was not (clearly) described in the original publication.

<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
<th>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</th>
<th>Time since injury</th>
<th>Methods used to determine RTW</th>
<th>RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glozier22; New Zealand</td>
<td>n: 210; a: 55(?-?) RTW, 56(?-?) NRTW; m/w: 144/66; stroke; (128 had stroke-related speech problems; degree of physical disability was independent in 111, moderately dependent in 67 and dependent in 29 (3 unknown); 154 infarction, 24 intracerebral haemorrhage, 28 subarachnoid haemorrhage, 4 undetermined)</td>
<td>6 months</td>
<td>Interview</td>
<td>53.3%</td>
<td>4</td>
</tr>
<tr>
<td>Alaszewski23; UK</td>
<td>n: 28; a: ?(30-59)<em>; m/w: (28/15)</em>; stroke; (without serious speech difficulties and cognitive impairments)</td>
<td>8-18 months</td>
<td>Interviews (flexibly structured)</td>
<td>39.5%</td>
<td>2</td>
</tr>
<tr>
<td>Hartman16; Israel</td>
<td>n: 39; a: 57.7(?-?)<em>; m/w: 42/14</em>; stroke; hemispheric or haemorrhagic; ?</td>
<td>1 year</td>
<td>Questions</td>
<td>2.6%</td>
<td>4</td>
</tr>
<tr>
<td>Wozniak17; USA</td>
<td>n: 156; a: 55.3(?-?)<em>; m/w: 136/67</em>; stroke (ischemic); ?</td>
<td>1 or 2 years</td>
<td>?</td>
<td>53% of the 109 people examined at 1-year follow-up; 44.7% of the 47 people examined at the 2-year follow-up</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 2 (continued)

<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
<th>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</th>
<th>Time since injury</th>
<th>Methods used to determine RTW</th>
<th>RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestling18; Sweden</td>
<td>n: 65; a: 54(median) (?-?); m/w: 41/24; stroke; (68% had cognitive impairments of which 41% had dysphasia; 66% suffered some physical impairment)</td>
<td>2-2.5 years</td>
<td>Questionnaire [validation unknown]</td>
<td>35.4%</td>
<td>4</td>
</tr>
<tr>
<td>Vestling24; Sweden</td>
<td>n: 120; a: 50(median) (?-?); m/w: 73/47; stroke; ?</td>
<td>2.7 (+/- 2.9) years</td>
<td>Questionnaire [validation unknown]</td>
<td>41%</td>
<td>3</td>
</tr>
<tr>
<td>°McLean25; Republic of Singapore</td>
<td>Stroke (infarct): n: 36; a: ?(21-65)<em>; m/w: 51/17</em>; stroke; ? Haemorrhagic stroke: n: 10; a: ?(21-65)<em>; m/w: 51/17</em>; stroke; ?</td>
<td>? (6 months post-discharge from inpatient rehabilitation)</td>
<td>Interview</td>
<td>Infarct: 47.2%; haemorrhagic: 40%</td>
<td>2</td>
</tr>
<tr>
<td>Saeki26; Japan</td>
<td>n: 173; a: ?(18-64)<em>; m/w: 129/54</em>; stroke; ?</td>
<td>? (at least 6 months after discharge)</td>
<td>Questionnaire [validation unknown]</td>
<td>56.6%</td>
<td>4</td>
</tr>
<tr>
<td>Saeki27; Japan</td>
<td>n: 173; a: ?(18-64)<em>; m/w: 124/106</em>; stroke; ?</td>
<td>? (at least 6 months after discharge, mean time 43 (8-77) months after discharge)</td>
<td>Questionnaire [validation unknown]</td>
<td>59.5%</td>
<td>4</td>
</tr>
<tr>
<td>Reference (first author; country)</td>
<td>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</td>
<td>Methods used to determine RTW</td>
<td>RTW</td>
<td>Score methodological quality (range 0-5)</td>
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<tr>
<td><strong>Subarachnoid haemorrhage</strong></td>
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<tr>
<td>Yap ‘19; Republic of Singapore</td>
<td>n: 24; a: 50.9(25-76)<em>; m/w: 21/18</em>; SAH; mild-severe</td>
<td>6 months</td>
<td>?</td>
<td>37.5%</td>
<td>4</td>
</tr>
<tr>
<td>Nishino ‘21; Japan</td>
<td>n: 193; a: 45.1(40-49)<em>; m/w: 122/71; SAH; (ADL status at discharge: 67.9% excellent, 19.7% good, 9.8% fair, 2.6% poor)</em></td>
<td>1 year</td>
<td>Mailed questionnaire [validation unknown] or telephone interview</td>
<td>Overall: 71.5%; RTW to same job and workplace: 58.5%</td>
<td>4</td>
</tr>
<tr>
<td>Wermer ‘20; The Netherlands</td>
<td>n: 420; a: 53.4(24-70)<em>; m/w: 219/391</em>; SAH; ?</td>
<td>8.9 (2.3-18.8) years</td>
<td>Interview</td>
<td>65.5%</td>
<td>4</td>
</tr>
</tbody>
</table>

*Based on the whole population included in the study; °Study included both non-traumatic and traumatic causes of ABI, only the results of non-traumatic causes are given here
Table 3: Results of the review concerning people with traumatic brain injury, ordered by time since injury. A question mark was registered if the variable was not (clearly) described in the original publication.

<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
<th>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</th>
<th>Methods used to determine RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruffolo(^\text{11}); Canada</td>
<td>n: 38; a: 31(19-55)<em>; m/w: 31/19</em>; TBI; mild</td>
<td>Questionnaire [validation unknown]</td>
<td>4</td>
</tr>
<tr>
<td>O’Connell(^\text{12}); USA</td>
<td>n: 32; a: 35.1(18-?)<em>; m/w: 26/17</em>; TBI; ?</td>
<td>Medical records</td>
<td>2</td>
</tr>
<tr>
<td>Ruff(^\text{30}); USA</td>
<td>n: 67; a: 25.7(15-65)<em>; m/w: 75/18</em>; TBI; severe</td>
<td>Interview</td>
<td>4</td>
</tr>
<tr>
<td>Dikmen(^\text{28}); USA</td>
<td>n: 24; a: 24.2(15-65)<em>; m/w: (20/11)</em>; TBI; severe</td>
<td>Structured interview</td>
<td>4</td>
</tr>
<tr>
<td>Felmingham(^\text{43}); Australia</td>
<td>n: 46; a: 34.2(?-?)<em>; m/w: 42/13</em>; TBI; mild-severe</td>
<td>Community Integration Questionnaire [adequate test-retest reliability and internal consistency]</td>
<td>4</td>
</tr>
</tbody>
</table>

RTW: Return to work
<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
<th>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</th>
<th>Methods used to determine RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>McLean</em>; Republic of Singapore</td>
<td>TBI: n: 5; a: ?(21-65)<em>; m/w: 51/17</em>; TBI; ? (6 months post-discharge from inpatient rehabilitation)</td>
<td>Interview 40%</td>
<td>2</td>
</tr>
<tr>
<td>Arango-Lasprilla; USA</td>
<td>n: 2461 (n: 1783 whites, n: 678 minorities); a: whites 38.81(?-?)<em>, minorities 36.11(?-?)</em>; m/w: 3884/1374*; TBI; mild-severe (primarily moderate-severe)</td>
<td>Centralized database 38.8% (whites: 44.48%; minorities: 23.75%)</td>
<td>4</td>
</tr>
<tr>
<td>Cifu; USA</td>
<td>n: 132; a: 33(18-63); m/w: 106/26; TBI; mild-severe</td>
<td>? 37.1%</td>
<td>4</td>
</tr>
<tr>
<td>Corrigan; USA</td>
<td>n: 3444; a: 35.6(18-64*); m/w: 2487/957; TBI; moderate-severe</td>
<td>Integrated dataset 58.9% (increased hours: 9.5%; same number of hours: 36.5%; decreased working: 12.9%)</td>
<td>4</td>
</tr>
<tr>
<td>Doctor; USA</td>
<td>n: 418; a: ?(below 25-50 and over); m/w: 334/84; TBI; mild-severe</td>
<td>Structured interview 58.4% (Men: 56.9%; women: 64.3%)</td>
<td>4</td>
</tr>
<tr>
<td>Greenspan; USA</td>
<td>n: 343; a: ?(18-?); m/w: ?/?; TBI; moderate-critical</td>
<td>Medical records, telephone interview 63%</td>
<td>2</td>
</tr>
</tbody>
</table>
How many people return to work after acquired brain injury?

Table 3 (continued)

<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
<th>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</th>
<th>Time since injury</th>
<th>Methods used to determine RTW</th>
<th>RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanlon^46; USA</td>
<td>tSAH: n: 24; a: 34(??); m/w: 17/7; TBI with SAH; moderate-severe</td>
<td>1 year</td>
<td>? (Rated by two authors on a 3-point scale)</td>
<td>tSAH: 42% (all different capacity or occupation); No tSAH: 66% (13% same capacity and occupation; 53% different capacity or occupation)</td>
<td>4</td>
</tr>
<tr>
<td>Hanlon^32; USA</td>
<td>n: 100; a: 35.6(??); m/w: 58/42; TBI; mild</td>
<td>1 year</td>
<td>? (Rated on a 3-point scale)</td>
<td>78% (33% same capacity and occupation; 45% different capacity or occupation)</td>
<td>4</td>
</tr>
<tr>
<td>Nakase-Richardson^34; USA</td>
<td>n: 171; a: ?(16-??); m/w: 120/51; TBI; mild-severe</td>
<td>1 year (10-14 months)</td>
<td>In-person or telephone interview</td>
<td>30%</td>
<td>4</td>
</tr>
<tr>
<td>Walker^33; USA</td>
<td>n: 1341; a: 35.0(18-62); m/w: 1033/308; TBI; mild-severe</td>
<td>1 year</td>
<td>Face-to-face (or telephone) interview (or mail questionnaire and/or interview)</td>
<td>39%</td>
<td>4</td>
</tr>
<tr>
<td>Kreutzer^35; USA</td>
<td>n: 186; a: 33.22(18-65); m/w: 147/39; TBI; mild-severe</td>
<td>1, 2, and 3 or 4 years</td>
<td>Interview</td>
<td>1 year: 37%; 2 years: 42%; 3 or 4 years: 45%</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 3 (continued)

| Reference (first author; country) | Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury) | Time since injury | Methods used to determine RTW | RTW | Score methodological quality (range 0-5)
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<tbody>
<tr>
<td>Levack; New Zealand</td>
<td>n: 7; a: (?26-51); m/w: 4/3; TBI; moderate-severe</td>
<td>1-1.5 years (n=3); 3.5 years (n=1); 7-8 years (n=3)</td>
<td>Interview (open ended)</td>
<td>71.5% (28.6% full-time; 14.3% part-time; 28.6% work trials)</td>
<td>4</td>
</tr>
<tr>
<td>Huebner ; USA</td>
<td>n: 16; a: 43.79(21.83-83.42)<em>; m/w: 17/8</em>; TBI; mild-severe</td>
<td>21 months (16-29 months)</td>
<td>Community Integration Questionnaire [adequate test-retest reliability and internal consistency]</td>
<td>31.3%</td>
<td>5</td>
</tr>
<tr>
<td>Ponsford; Australia</td>
<td>n: 106; a: 27.4(?-?)<em>; m/w: 109/66</em>; TBI; mild-extremely severe</td>
<td>2 years</td>
<td>Structured interview</td>
<td>2% (33% full-time; 9% part-time)</td>
<td>4</td>
</tr>
<tr>
<td>McCrimmon; UK</td>
<td>RTW: n: 20; a: 32.05(18-55); m/w: 13/7; TBI; moderate-severe NRTW: n: 13; a: 34.23(18-55); m/w: 9/4; TBI; moderate-severe</td>
<td>0.5 – 4 years (RTW: mean 111.8 +/- 34.67 weeks; NRTW: mean 109.00 +/- 55.39 weeks)</td>
<td>Questionnaire [validation unknown]</td>
<td>60.6%</td>
<td>4</td>
</tr>
<tr>
<td>Ponsford; Australia</td>
<td>n: 74; a: 29.5(16-59); m/w: 48/26; TBI; mild-severe</td>
<td>2 years</td>
<td>Interview</td>
<td>40% (32.4% full-time; 8.1% part-time)</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 3 (continued)

<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
<th>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</th>
<th>Time since injury</th>
<th>Methods used to determine RTW</th>
<th>RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponsford³⁹; Australia</td>
<td>n: 1268 were seen at least once (571 at 1 year, 588 at 18 months, 591 at 2 years, 384 at 3 years, 316 at 5 years, 32 at 10 years post-injury) (on average 70% were working before injury); a: (?) (TBI; moderate-very severe)</td>
<td>? (follow-up at 1, 1.5, 2, 3, 5, and 10 years after discharge)</td>
<td>Interview</td>
<td>2 years: 55% of those working before injury; 5 years: 43% of those working before injury</td>
<td>3</td>
</tr>
<tr>
<td>Avesani⁵¹; Italy™</td>
<td>n: 230; a: 27.7(18-68)RTW / 29.7(18-68)NRTW; m/w: (275/78)*; TBI; severe</td>
<td>2-10 years</td>
<td>Telephone interviews (EBIS protocol)</td>
<td>54.3%</td>
<td>5</td>
</tr>
<tr>
<td>Franulic⁵²; Chile</td>
<td>2yrs PI: n: 70; a: 37.3(2-?)RTW / 40.9(2-?)NRTW; m/w: ?/?; TBI; mild-severe 5yrs PI: n: 72; a: 40.5(2-?)RTW / 43.4(2-?)NRTW; m/w: ?/?; TBI; mild-severe 10 yrs PI: n: 58; a: 36.3(2-?)RTW / 39.3(2-?)NRTW; m/w: ?/?; TBI; ?</td>
<td>2, 5, or 10 years</td>
<td>Interview</td>
<td>2 years PI: 53.5%; 5 years PI: 55.6%; 10 years PI: 69%</td>
<td>3</td>
</tr>
<tr>
<td>Fraser³⁷; USA</td>
<td>n: 140; a: 35(2-?); m/w: 118/22; TBI; mild-severe</td>
<td>1 month, 6 months, 1 year, and 3-5 years</td>
<td>Structured interview</td>
<td>61.4% working at 3-5 yrs post-injury; 25.7% worked at some time post-injury but did not sustain it at 3-5 years post-injury</td>
<td>4</td>
</tr>
<tr>
<td>Reference (first author; country)</td>
<td>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</td>
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<tr>
<td>Girard(^{30}); USA</td>
<td>n: 114; a: 31(13-70)*; m/w: 100/54; TBI ; ? (neuropsychological status improved from moderately impaired initially to mildly impaired at least 18 months post-injury)</td>
<td>3 years (6 months – 12 years)</td>
<td>McAuley Outcome Scale [validation unknown]; structured telephone interview; follow-up reports</td>
<td>62%</td>
<td>3</td>
</tr>
<tr>
<td>Ip(^{54}); Canada</td>
<td>n: 33; a: 33.2(17-63); m/w: 38/7*; TBI; mild-severe</td>
<td>3.1 (+/-?) years</td>
<td>Telephone interview</td>
<td>36.4%</td>
<td>4</td>
</tr>
<tr>
<td>Watt(^{65}); South Africa</td>
<td>n: 37; a: 29.83(?-?)<em>; m/w: 37-13</em>; TBI; mild-severe</td>
<td>41 (+/- 17) months</td>
<td>Medico-legal records</td>
<td>51.4%</td>
<td>4</td>
</tr>
<tr>
<td>Murphy(^{56}), UK</td>
<td>n: 162; a: 33(17-62)<em>; m/w: 190/28</em>; TBI; mild-extremely severe</td>
<td>7 months – 35.5 years (mean 5.5 +/- 6 years)</td>
<td>Administrative databases and paper-based records</td>
<td>45.7% (and 21% voluntary work)</td>
<td>4</td>
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Table 3 (continued)

<table>
<thead>
<tr>
<th>Reference (first author; country)</th>
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<th>RTW</th>
<th>Score methodological quality (range 0-5)</th>
</tr>
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<tbody>
<tr>
<td>Guerin*; Canada</td>
<td>n: 110; a: 37.4(-?); m/w: 70/40; TBI; mild</td>
<td>? (3.3 months (2 weeks – 3 years) = start intervention)</td>
<td>Medical records</td>
<td>49%</td>
<td>3</td>
</tr>
<tr>
<td>Catalano*; USA</td>
<td>n: 7366; a : 36.8(-?); m/w: 4862/2504; TBI; ?</td>
<td>(average time between applying and eligibility to Vocational Rehabilitation service 1.54 (+/- 2.45) months; average time between eligibility and case closure 30.23 (+/-20.98) months)</td>
<td>Data extracted from database</td>
<td>Data extracted from database</td>
<td>1</td>
</tr>
<tr>
<td>Power*; USA</td>
<td>10; ?(25-56); m/w: 5/5; TBI; ?</td>
<td>&lt;5 years (n=8) or &gt;10 years (n=2)</td>
<td>Interview</td>
<td>40%</td>
<td>2</td>
</tr>
<tr>
<td>Reference (first author; country)</td>
<td>Subjects and severity of injury (number of subjects of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury)</td>
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</tr>
<tr>
<td>Bounds(^{39}); USA</td>
<td>n: 78; a: 36.7(18-57); m/w: 55/23; TBI; ?</td>
<td>Data extracted from the database of the Missouri Division of Vocational Rehabilitation</td>
<td>17.9% (23.6% men; 4.4% women)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
| Grosswasser\(^{31}\); Israel     | PHI: n: 74; a: 36(?-?); m/w: ?/?; TBI; mild-severe  
CHI: n: 37; a: 37(?-?); m/w: ?/?; TBI; mild-severe | Clinical evaluation | PHI: 52%; CHI: 84% | 3 |
| Schwab\(^{60}\); USA             | n: 520; a: 36(?-?); m/w: 520/0; PHI; mild-severe? | Interview | 56% | 3 |

*Based on the whole population included in the study; °Study included both non-traumatic and traumatic causes of ABI, only the results of traumatic causes are given here; †Included subjects of different countries

TBI: traumatic brain injury; NTBI: non-traumatic brain injury; PHI: penetrating head injury; CHI: closed head injury; (t)SAH: (traumatic) subarachnoid haemorrhage; ABI: acquired brain injury; RTW: return to work; NRTW: no return to work
### How many people return to work after acquired brain injury?

| Reference | Methods used to determine RTW | Time since injury | Subjects and severity of injury (number of subjects and of which RTW is known (n); age (mean (range)); gender (number men/women); injury; severity of injury) | Score methodological quality (range 0-5) | Score methodology
|---|---|---|---|---|---|
| Leung et al. Hong Kong | Medical records | ? (at least at discharge) | n: 79; a: 42-85/17-65; m/w: 59/21; TBI and NTBI; ? (degree of physical deficits: normal (54.4%), mild (26.6%), moderate (16.5%), or severe (2.5%)) | 2 | 2
| Hinckley et al. USA | Community Integration Questionnaire [adequate test-retest reliability and internal consistency] | 44.5 (30-127) months | n: 15; a: 48/19-82; m/w: 12/8; left hemispheric stroke (n=18); TBI (n=1); or multiple strokes (n=1); all having aphasia | 5 | 3
| Pössl et al. Germany | Structured interview | 7-8 years | n: 43; a: 33-17-50; m/w: 27/16; TBI; stroke or other brain diseases; minor residual impairments-persistent neuropsychological impairments and psychopathological symptoms | 3 | 3

*Based on the whole population included in the study

Comparison of percentage RTW between people with non-traumatic and traumatic ABI

From the abovementioned results, it can be concluded that most studies including people with either a non-traumatic or traumatic cause of ABI reported percentages between 30% and 65% RTW. Overall estimates of 64.8% after 1 year and 39.3% after 2 years were obtained for people with non-traumatic ABI. RTW estimates of 40.7% after 1 year and 40.8% after 2 years were obtained for patients with traumatic ABI. Because for both causes (non-traumatic and traumatic) and both times since injury (1 year and 2 years) different studies were included, the overall estimates of percentages were all based on a different number of studies. From these results there seems to be a substantial difference in RTW between non-traumatic and traumatic ABI only at the 1-year follow-up time-point.

Development of RTW over time

The development of percentage RTW over time can be studied between and within subjects. Four studies were found in which the percentage RTW was reported between subjects at different time periods; all patients suffered traumatic ABI. Kreutzer et al.\textsuperscript{35} reported that 37% of subjects were employed at 1 year, 42% at 2 years, and 45% at 3 or 4 years post-injury. Ruff et al.\textsuperscript{30} observed 18% return to work during the first 6 months, whereas 32.8% were returned after 1 year following injury. Franulic et al.\textsuperscript{52} investigated RTW after 2, 5, or 10 years and reported 53.5%, 55.6%, and 69% RTW, respectively. According to these results, RTW seems to increase over time. Only Ponsford and Olver\textsuperscript{39} reported a decrease of RTW over time: 55% RTW at 2 years post-injury and 43% RTW at 5 years post-injury.

From the above-mentioned results it can be concluded that the percentage of RTW seems to increase over time. However, it is not clear whether the return to work was permanent, with some people needing a longer time period to return to work than others, or whether different people were working at different times. To investigate not only the progression of RTW over time but also to determine whether RTW could be maintained by individual subjects over time, the sustainability of RTW is investigated through four studies highlighting stability. All studies included people with a traumatic cause of ABI. Fraser et al.\textsuperscript{37} investigated job sustainability in people with mild to severe brain injury. In this study 61.4% of the 140 participating subjects were working at 3-5 years post-injury; 25.7% of the subjects had been working at some point post-injury but could not sustain employment at 3-5 years post-injury; 12.9% had never returned to work. Kreutzer et al.\textsuperscript{35} coded job stability of the subjects with mild to moderate traumatic brain injury. Those who were employed at all three follow-up times (1, 2, and 3 or 4 years) were coded as stably employed; those who were employed at one or two follow-up times were coded as unstably employed and those who were not employed at any of the follow-up times were coded as unemployed. According to this classification 34% were coded as stably employed, 27% as unstably employed, and 39% as unemployed. Of the 65 subjects who
were employed at 1 year post-injury, 55 subjects remained employed at 2 years and 59 subjects were employed at 3 years post-injury. Felmingham et al.\textsuperscript{43} studied 19 subjects who were employed at 6 months after discharge. Of these subjects, 15 (78\%) were still employed 2 years after discharge. In the study of Ruff et al.\textsuperscript{30} all subjects with severe traumatic brain injury who returned to work during the first 6 months following injury were still working at 1 year. From these studies it can be concluded that not all people with traumatic brain injury are able to sustain their job over time, but that a substantial percentage of those people who are employed after ABI are. However, the studies that investigated percentage RTW of the same people at different time-points had a maximum follow-up period of 5 years and did not include patients suffering from non-traumatic causes of ABI.

\textbf{Changes in occupation and job demands}

Nishino et al.\textsuperscript{21} reported that 71.5\% of the participating subjects with subarachnoid haemorrhage returned to work overall, but only 58.5\% returned to the same job and workplace. Dikmen et al.\textsuperscript{28} found that only one of 11 subjects with traumatic brain injury who returned to work returned to the same position and employer. Hanlon et al.\textsuperscript{32,46} investigated RTW of people with mild traumatic injury\textsuperscript{32} and moderate to severe traumatic brain injury with and without traumatic subarachnoid haemorrhage.\textsuperscript{46} One third (n=33) of the subjects with mild traumatic brain injury returned to the same occupation within the same capacity and 45\% (n=45) returned to a different occupation or to their former occupation but in a different capacity.\textsuperscript{32} Of the 76 people with moderate to severe traumatic brain injury without traumatic subarachnoid haemorrhage, 10 subjects returned to the same occupation and 40 subjects moved to a different occupation or capacity. Among those with traumatic subarachnoid haemorrhage all 10 of the 24 subjects who returned to work took on new occupations or different capacities at their former jobs. Leung and Man\textsuperscript{61} studied subjects with traumatic and non-traumatic ABI; 29 of the 79 subjects returned to the same job title, job nature, and demands while eight of the 79 subjects had a change of job title, nature, and demands. From the results of these studies it is clear that changes in occupation and job demands are common among people following ABI.

\textbf{Discussion}

The main purpose of the current review was to give a systematic overview of the number of people returning to work after ABI. After pooling the results for an overall estimate of RTW, it was clear that almost two-thirds of the subjects with non-traumatic ABI returned to work after 1 year and two-fifths after 2 years. Among people with traumatic ABI, two-fifths had returned to work by both the 1- and 2-year time-points.
A remarkable high estimate of percentage RTW was found in people with non-traumatic brain injury at 1 year post-injury compared to the estimates of percentage RTW in people with traumatic ABI and the estimate at 2 years post-injury in people with non-traumatic ABI. This could be the result of the criteria for inclusion in the data pool. Because no generally known classification of injury severity in non-traumatic ABI is well-accepted, all studies at 1- or 2-years follow-up were included. However, in the study of Nishino et al. people with subarachnoid haemorrhage participated 1 year post-injury, almost all having a good neurological condition and a good to excellent ADL status at discharge. It can be questioned, therefore, whether the results of this study were comparable to the results of the other included studies and whether this study should have been included for pooling. Excluding the study of Nishino et al. leaves only one study for the pool. A more uniform definition of severity in non-traumatic brain injury could have improved the comparability of the estimates.

When looking at the percentages of RTW more descriptively and after excluding the outliers between 30% and 65% RTW was found overall, for those with traumatic and non-traumatic ABI. It is interesting to see that, although return to work is getting more and more important because of economic reasons and changes in disability legislation, the number of people returning to work after ABI did not remarkably change over the past decades. The range in percentages of RTW that were found in the current review were more or less comparable to the outcomes of past reviews. For example, Treger et al. found 19-73% RTW following stroke, based on the literature published between 1975 and 2004. Furthermore, Shames et al. reported 12.5-70% RTW in people with traumatic brain injury, based on the results of studies published between 1990 and 2001. The broad definition of RTW in these reviews and the less structured search strategies could explain the enormous range in these two reviews. The ranges for these studies and for this review could also be due to differences in social assurance system and legislation in the countries of the included studies. As shown in tables 2, 3, and 4 the measures studied varied greatly across countries, especially for non-traumatic ABI. The social assurance systems and legislation of these countries vary in the degree to which programs push people to return to work. In some countries there is no urgent need to return to work because people receive income compensation during sick leave, whereas in many other countries people receive zero or negligible income compensation and have to work in order to earn a living. Another possible explanation of the broad range of RTW were the differences in time since injury between the studies: some reported RTW after 6 months whereas others reported RTW after 15 years.

One of the additional purposes of the current review was to explore the differences in percentages RTW between people with traumatic and people with non-traumatic ABI. As can be concluded from the results discussed above, after 2 years since injury 39.3% RTW was obtained for people with non-traumatic ABI. For people with traumatic ABI 40.7% RTW after 1 year and 40.6% RTW after 2 years was obtained. This means that
How many people return to work after acquired brain injury?

about two-fifths of the people with traumatic or non-traumatic ABI returned to work within 2 years since injury. From these results it is concluded that the cause of brain injury does not seem to influence the success of RTW.

The second additional purpose of this report was to investigate the progress of RTW over time. Three studies reported an increase of percentage RTW over time in people with traumatic brain injury, whereas one other study and the overall estimates of the current study did not show a change of percentage RTW over time. In addition, it became clear that some but not all of those with traumatic brain injury who return to work are able to sustain their job over time. No studies were found in which the progress and sustainability of RTW in people with non-traumatic ABI was investigated. Future studies and rehabilitation programs should help to explore the progress of RTW over a longer period of time and in people with non-traumatic brain injury therefore. However, because in the current review there seems to be no difference in RTW between people with traumatic and non-traumatic ABI, no effect of injury cause on the progress and sustainability of RTW is expected.

The last purpose of the study was to explore whether people were able to return to their former occupation and successfully maintain the same job demands. Only a few studies were found investigating this issue, but the results from these few studies show that changes in occupation and job demands are common among people following ABI.

ABI is often perceived as one of the most disabling diseases.\textsuperscript{10} It affects both physical and cognitive functions, while most other chronic disorders affect only one of these systems. It could therefore be expected that RTW rates for people with ABI are lower compared to RTW rates of those with other diseases. Recently Lidal et al.\textsuperscript{64} reviewed RTW following spinal cord injury, a generally physical condition. According to that review 21-67\% of the people who were working before spinal cord injury returned to work. This is comparable to the rate of RTW after ABI. Burger & Marincek\textsuperscript{65} reviewed the literature on RTW of people with lower limb amputation. Due to different criteria for RTW and varying amputation levels of the participating subjects, a broad range of RTW was found, from 17-87\%, but with most studies reporting around 66\% RTW. However, that review also included people who were unemployed prior to the injury. Sterner and Gerdle\textsuperscript{66} studied RTW in people with acute and chronic whiplash-associated disorders and reported 92-95\% RTW. However, among those with residual symptoms, one-third had difficulties returning to work. It remained unclear whether those people were working before the injury. In conclusion, the number of people that return to work after ABI seems to be comparable to the RTW rates of people with spinal cord injury, but less encouraging compared to the rates for less disabling disorders like amputation and whiplash-associated disorders.
Limitations of the study
To perform a systematic literature search, it was decided to include only studies in which subjects were working in a paid or volunteer job before injury in order to look more specifically at the return to work of people with ABI. Many studies were excluded because they used other inclusion criteria, such as those listing studying as a form of employment. According to the reviews of Treger et al. and Shames et al., injury severity is a significant negative predictor of RTW. In the current review it was not possible to make a distinction based on injury severity, as in most studies people with mild to severe ABI were included, without splitting the results based on severity. The pooled estimation of RTW was therefore also based on people with mild to severe ABI. Future studies will be necessary to compare RTW rates among those with mild, moderate, and severe injury.

Clinical implications
As was mentioned in the introduction, employment is a factor of participation that positively influences different aspects of life: people who are employed report a better sense of wellbeing, better health status, greater social integration within the community, less health service usage, more social contacts, and a better quality of life than people who are not employed. From the results, however, it can be concluded that more than half of the subjects with ABI do not return to work and that not all subjects are able to make a stable transition in returning to their former occupation. In order to try to increase the number of people that return to work and increase the sustainability of RTW, attention should be paid to the return to work as part of the (vocational) rehabilitation process. In order for such a program to be effective, the focus should be on the (identification of) prognostic factors of RTW and job stability.

Conclusion
In the current study 12 studies were found in which RTW after non-traumatic ABI was investigated and 35 studies were found in which RTW after traumatic ABI was investigated. According to the results of these studies 35-60% of the people with non-traumatic ABI and 30-65% of the people with traumatic ABI returned to work. The pooled overall estimates were 39.3% RTW after 2 years of injury for people with non-traumatic ABI and 40.7% RTW after 1 year and 40.6% RTW after 2 years for people with traumatic ABI. According to these findings it can be concluded that two-fifths of the subjects with non-traumatic or traumatic ABI returned to work within 2 years post-injury. A substantial portion of the subjects were either unable to return to their former work or unable to return in a durable way.
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References


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47. Levack W, McPherson K, McNaughton H. Success in the workplace following traumatic brain injury: are we evaluating what is most important? Disability and Rehabilitation 2004, 26(5), 290-298.


64. Lidal IB, Huynh TK, Biering-Sorensen F. Return to work following spinal cord injury: a review. Disability and Rehabilitation 2007, 29(17), 1341-1375.
Appendix: Search strategy

**Pubmed**
Limitations: Publication date: 01 January 1992 to 31 July 2008; Language: English, German, or Dutch

Brain injury [MESH] OR Traumatic brain injury OR Acquired brain injury OR TBI OR ABI OR Brain injur* OR Cerebrovascular accident OR CVA OR Stroke [MESH] OR Intracranial Haemorrhages [MESH]

AND


**Embase**
Limitations: Publication date: 01 January 1992 to 31 July 2008; Language: English, German, or Dutch


AND


**Cinahl**
Limitations: Publication date: 01 January 1992 to 31 July 2008; Language: English, German, or Dutch

How many people return to work after acquired brain injury?


AND


PsycINFO
Limitations: Publication date: 01 January 1992 to 31 July 2008; Language: English, German, or Dutch; Document type: Journal article or Publication information

Brain injury OR Traumatic brain injury OR Acquired brain injury OR TBI OR ABI OR Brain injur* OR Cerebrovascular accident OR CVA OR Stroke OR Intracranial haemorrhage

AND

Work OR Occupation OR Employment OR Vocational rehabilitation OR RTW OR Return to work OR Supported employment OR Re-employment OR Employment status OR Work resumption OR Unemployment OR Work re-entry OR Participation