Health Consequences of Bicycle Crashes

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ABSTRACT

The aim of this study was to health consequences related to involvement in a bicycle crash. This was done by investigating the crash’s impact health-related quality of life (HRQoL). The HRQoL was investigated using data collected between March 9th and April 27th, 2020 using a self-report online survey. The survey contained a version of the Late Effect of Accidental Injury Questionnaire and participants were selected based on indicating involvement in a bicycle crash in the most recent 2 years. The final sample consisted of 358 cyclists having suffered a bicycle crash in the within the past two years. The results showed that 27.3% percent of the participants reported at least one negatively impacted health aspect, with physical (13.5%) and psychological (12.3%) health aspects being the most frequently reported ones. The use of the LEAIQ, compared to generic health surveys, allows us to reveal specifically which health changes, compared to before the injury, are considered to be specifically related to the injury. This allowed for more specific insight into the health consequences of bicycle crashes and revealed that of the participants reporting negative impacts on their HRQoL 78% considered it to be related to their crash.

Keywords: bicycle crash consequences, health impact, HRQoL, survey analysis, road traffic safety
1 INTRODUCTION

In order to create more awareness and knowledge on the long-term consequences related to injuries sustained in road traffic crashes, the recent decades have witnessed an increase of research regarding burden of health consequences of road traffic injuries.

Many such studies have tried to sum up this burden in terms of single measures and compare these across injury types etc. (Haagsma et al., 2012; Polinder et al., 2015; Tainio et al., 2014; Weijermars et al., 2016). Disability adjusted Life Years (DALYs) have become an especially popular tool in this regard. DALYs provide a framework for combining the burden related to mortality (year of life lost) as well as morbidity (year lived with disease) following a road traffic injury. Where the burden of a given injury is dependent on a set of generic disability weights derived across diseases (Murray & Acharya, 1997). However, because the DALYs are disease specific combining them is not as such possible.

The HRQoL however, being the health-related subset of the individual’s quality of life, incorporates the individual’s own perception of the injury and represents a multidimensional perspective of health that takes into account physical, psychological and social functioning and well-being (Bowling, 2001). Understanding the effects of a crash on different health aspects could prove important to fully understand the health consequences of accidental injuries. For example Haagsma et al. (2011) show that psychological consequences greatly affects recovery following road traffic injuries. While studies by Ohlin et al. (2017), as well as Tournier et al. (2014) find that the psychological impact of bicycle crashes only trail the physical impact as most frequently reported in studies evaluating the HRQoL.

Given the increased endorsement of active mobility in recent years, especially bicycling (Infrastructures, 2015), and their assumed vulnerability and future increase of crashes reported, many of the studies have been interested in how the long-term health consequences following
accidents differ between transport modes (Craig et al., 2016; Tainio et al., 2014; Weijermars et al., 2016).

Most, if not all, of these studies, rely on hospital data or national register data either for direct use or to short-list individuals to survey. This is a problem since hospital and register data suffer from under-reporting stemming from reporting bias of especially minor injuries, when it comes to bicycle crashes. For example a study by De Geus et al. (2012) shows that only 17% of recorded bicycle crashes in a proposed cohort study in Belgium reported bicycle crashes to the emergency department, and even fewer reported their crashes to the police. Thereby studies might not be presenting the full picture when limiting data to that registered by hospital. Furthermore, many of the studies considering the HRQoL following road traffic crashes use generic health surveys, such as the EuroQoL-5D (EQ-5D) (Rabin & de Charro, 2001). While this specific survey has been previously used with road traffic injuries (Gabbe et al., 2015). There is the short coming that these do not directly associate the described health consequences or the health domain, to the crash itself, i.e. a person could have suffered from something different that need not relate to the original injury.

The aim of this study is to investigate the health related quality of life and the health consequences regarding physical, psychological, social, economic health, following implication in a bicycle crash, through the use of a questionnaire specifically created to evaluate the health-effects of road traffic injuries, thereby allowing to identify specific contribution of the accident. Meanwhile, it is believed that distributing the questionnaire on an on-line survey platform will allow us to overcome the reporting bias issue, allowing for the most truthful description of the health consequences of bicycle crashes.
2 METHODOLOGY

2.1 Study design

In this study we analysed cross-sectional data collected through an on-line survey, distributed through social and university networks as well as being distributed by the SoMe department of The Council for Traffic safety and a link in the Danish Cyclist Federation newsletter. The data collection period lasted from March 9th until April 27th. The total number of participants that reported crashes was 358 (50% male, 50% female). The participants were distributed evenly between the ages 15-75.

2.2 Content of survey and measurements

Individuals were asked to supply information regarding their most recent crash: month and year, duration suffered from ailments, type of crash, and describe what injuries were sustained. To be able to investigate the health consequences, participants were asked to fill out a slightly modified form of the Late Effect of Accidental Injury Questionnaire (LEAIQ) (Malt, 1988). This questionnaire investigates effects of accidental injuries on different health aspects such as physical, psychological, social, leisure and economic, and should therefore be well suited to describe the HRQoL of an individual following a bicycle crash.

The questionnaire addresses the consequences regarding these health aspects by asking the questions in Table 1.

Table 1: Overview of questions addressing the different health aspects

<table>
<thead>
<tr>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the participant has suffered permanent physical changes following the crash? (PPC)</td>
</tr>
<tr>
<td>Has the participant suffered reduced mobility following the crash, and does he still? (RPF)</td>
</tr>
<tr>
<td>How is the participant’s overall bodily health compared to before the crash? (BH)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Psychological</th>
</tr>
</thead>
</table>

4
How are the participant’s overall psychological health/nerves compared to before the crash? (PsH)

Has the participant been bothered by any of 24 specified stress/anxiety markers in the past 6 months, and which? (SSC)

**Social and leisure time**

How has the participant’s contact with the family compared to before the crash? (CoF)

How has the participant’s contact with others been, compared to before the crash? (CO)

How has the participant’s pleasure of leisure time activity been, compared to before the crash? (PL)

**Economic**

How has the participant’s economic situation been, compared to before the crash? (Econ)

How much has the participant been able to work following accident (i.e. change in work capacity), in relation to the previous standard? (CaW)

Has the participant’s work occupation changed? (ChW)

The questions regarding overall change compared to before the incident were all marked by the participant’s as either “improved”, “unchanged” or “worse”. The questions on physical change and functioning, PPC and RPF, were marked with “yes” or “no”. The question on change in work capacity, CaW could be answered with: “full time”, “most of the time”, “little or not at all” or “I cannot work or care for myself”. On the change of work, ChW, question, people could choose the from responses: “same as before”, “different than before”, “sickness benefit/rehabilitation”, “disability pension” or “old age pension”.

Lastly participants were asked if their amount of cycling compared to before the crash had decreased, stayed the same, or increased.

All questions regarding a change in a status compared to that before the crashes were equipped with a follow-up question forcing the participant to indicate whether or not the accident was causal of or related to the current state. This is an important consideration, as health of any individual could also develop in any direction regardless of any incident.
A negative impact of any of the aspects of overall health were associated to a negative impact on the HRQoL.

3 RESULTS

3.1 Crash and injury characteristics

3.1.1 Age and Gender

The study ended up consisting of 358 (50% female, 50% male) participants that had suffered at least one bicycle crash in the past two years. Specifically, 259 reported to have been suffered one crash, while 100 responded to have suffered several. Based on the age groups most of the reported crashes were experienced by participants in the age group 25-34 years of age (26.8%), followed by those 55-64 (19.2%) and 65-74 (16.5%) years of age.

3.1.2 Accident types

The majority of the reported crashes for both genders were single-bicycle crashes, making out approximately 60% of the bicycle crashes for male bicyclists and 50% for female (see Table 2). Other than that, 13% of male cyclist’s had a collision with a car and the same amount suffered collisions with pedestrians. For females this number is approximately 18% for both types. The of the crashes were classified as either collision with other cyclists or “other” crash types.

Table 2: Gender based distribution of crash types experienced.

<table>
<thead>
<tr>
<th></th>
<th>Single-bicycle</th>
<th>Collision with car</th>
<th>Collision with cyclist</th>
<th>Collision with pedestrian</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (N=179)</td>
<td>64.2%</td>
<td>12.9%</td>
<td>5.6%</td>
<td>12.9%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>
3.1.3 Injuries sustained

The injuries sustained were grouped into the categories shown in Table 3. It is evident that almost all of the crashes resulted in a type of superficial injuries. Furthermore, eye and facial injuries are also rather common. Lower extremity injuries and/or fractures are observed for approximately 20% of the crashes, approximately half of them being fractures.

<table>
<thead>
<tr>
<th></th>
<th>Single-bicycle</th>
<th>Collision with car</th>
<th>Collision with cyclist</th>
<th>Collision with pedestrian</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (N=179)</td>
<td>55.3%</td>
<td>18.4%</td>
<td>6.7%</td>
<td>16.8%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Total (N=358)</td>
<td>59.8%</td>
<td>15.6%</td>
<td>6.2%</td>
<td>14.8%</td>
<td>3.6%</td>
</tr>
</tbody>
</table>

When disclosing the approximate time that the participants had suffered ailments following the crashes shown in Table 4, most people (approx. 50%) reported ailments lasted one week or less. This indicates that many participants in the survey only suffered minor injuries from their crashes. Meanwhile, the proportion of participants reporting longer durations of ailments, declined as a function of increased ailment duration.
When asked if the crash was severe, 25% of the respondents felt that their crash had been severe. In Table 4 we see the self-reported time that people suffered ailments following the accident.

<table>
<thead>
<tr>
<th>Ailment time</th>
<th>&lt; 1 week</th>
<th>~ 1 week</th>
<th>~ 2 weeks</th>
<th>~ 3 weeks</th>
<th>~ 4 weeks</th>
<th>1-3 months</th>
<th>3-6 months</th>
<th>6-12 months</th>
<th>&gt;= 12 months</th>
<th>not yet recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
<td>89</td>
<td>36</td>
<td>26</td>
<td>22</td>
<td>57</td>
<td>9</td>
<td>15</td>
<td>12</td>
<td>29</td>
</tr>
</tbody>
</table>

Regarding the number of “not recovered” respondents, this need not directly indicate long and severe suffering but can also be an indication of a very recent incident.

### 3.2 Health Consequences of Accidental Injuries

In this section we summarise the outcomes regarding the effects on the different health aspects (physical, psychological, social and economic) that participants experienced following their most recent bicycle crash.

Firstly, we evaluate the overall responses regarding the different health domains, and how the participants have experienced change regarding their health compared to before the crash. Also, the negatively impacted health aspects, where participants considered the impact was related to the accident, were combined with the type of injury that the participants suffered.

Following this we further evaluate the health aspects and implications following the crashes.

### 3.2.1 Impact on health aspects following accidental injury.

The frequency of the changes/impact of the different health aspects experienced by the participants are shown in Table 5.
Table 3: The distribution of the frequency of the outcomes according to the Late Effect of Accidental Injury Questionnaire (LEAIQ) and amount of cycling compared to before the bicycle crash

<table>
<thead>
<tr>
<th>Change in health aspects after crash</th>
<th>Improved</th>
<th>Unchanged</th>
<th>Worsened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall HRQoL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HrQoL</td>
<td>17.3%</td>
<td>55.4%</td>
<td>27.3%</td>
</tr>
<tr>
<td>HRQoL related to the crash</td>
<td>5.6%</td>
<td>73.1%</td>
<td>21.3%</td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPC</td>
<td>-*</td>
<td>82.5%</td>
<td>17.5%</td>
</tr>
<tr>
<td>RPF</td>
<td>-</td>
<td>72%</td>
<td>28%</td>
</tr>
<tr>
<td>RPF still</td>
<td>=</td>
<td>86%</td>
<td>14%</td>
</tr>
<tr>
<td>BH</td>
<td>5.6%</td>
<td>80.8%</td>
<td>13.5%</td>
</tr>
<tr>
<td>BH related to the crash</td>
<td>1.1%</td>
<td>-</td>
<td>11.7%</td>
</tr>
<tr>
<td>Psychological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSH</td>
<td>1.4%</td>
<td>86.4%</td>
<td>12.3%</td>
</tr>
<tr>
<td>PSH related to the crash</td>
<td>0.3%</td>
<td>-</td>
<td>10.6%</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP</td>
<td>5.3%</td>
<td>86.6%</td>
<td>8.1%</td>
</tr>
<tr>
<td>LP related to the crash</td>
<td>3.6%</td>
<td>-</td>
<td>7.5%</td>
</tr>
<tr>
<td>CoF</td>
<td>2.0%</td>
<td>95.8%</td>
<td>2.2%</td>
</tr>
<tr>
<td>CoF, related to the crash</td>
<td>1.7%</td>
<td>-</td>
<td>2.0%</td>
</tr>
<tr>
<td>CO</td>
<td>0.8%</td>
<td>93.3%</td>
<td>5.6%</td>
</tr>
<tr>
<td>CO, related to the crash</td>
<td>0%</td>
<td>-</td>
<td>4.8%</td>
</tr>
<tr>
<td>Economic situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ</td>
<td>7.0%</td>
<td>88.8%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Econ, related to the crash</td>
<td>0.3%</td>
<td>-</td>
<td>1.7%</td>
</tr>
<tr>
<td>Cycling habits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyc</td>
<td>11.6%</td>
<td>73.4%</td>
<td>14.0%</td>
</tr>
<tr>
<td>Cyc, related to the crash (N=102)</td>
<td>3.7%</td>
<td>13.1%</td>
<td>11.7%</td>
</tr>
</tbody>
</table>

*: Indicating that no possible choice of that type was available to participants
In Table 5 it is seen that health aspects most frequently subject to negative impacts following crashes are the physical and psychological. This concerns both the overall changes since the crash and amongst the ones that feel changes are related to the crash. Combined 27.4% complained of worsening in any “aspect” of health (i.e. the HRQoL) compared to prior to the incident, 40% of whom experienced worsening in several domains. However, only 78% of these claims are considered by the participant to be related to the crash involvement. Meanwhile, some also report improved health aspects and sometimes even consider this to be related to the crashes.

Looking into the relation of impacted health aspects to the different types of injuries suffered in Table 6, it is seen that upper and lower extremity fractures and injuries and head and neck injuries are most often related to negative impacts on the HRQoL. Meanwhile, it is evident that the injuries also are related to different impacts on the different health aspects. For example, internal and torso injuries are related to the seconds highest frequency of negative impact reported, meanwhile is associated to the fewest reports of impacted psychological health.

<table>
<thead>
<tr>
<th>Participant’s reported injury</th>
<th>BH</th>
<th>PsH</th>
<th>Econ</th>
<th>LP</th>
<th>CoF</th>
<th>Co</th>
<th>HRQoL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial inj., Open Wounds (N=272)</td>
<td>8.2%</td>
<td>8.9%</td>
<td>1.1%</td>
<td>6.0%</td>
<td>1.5%</td>
<td>3.7%</td>
<td>17.5%</td>
</tr>
<tr>
<td>Head inj. spine or neck inj. (N=45)</td>
<td>24.4</td>
<td>20%</td>
<td>2.2%</td>
<td>8.9%</td>
<td>4.4%</td>
<td>6.7%</td>
<td>35.6%</td>
</tr>
<tr>
<td>Eye or Facial inj. (N=111)</td>
<td>21.6</td>
<td>14.1</td>
<td>3.6%</td>
<td>12.6%</td>
<td>3.6%</td>
<td>9.0%</td>
<td>31.5%</td>
</tr>
<tr>
<td>Internal or torso inj. (N=27)</td>
<td>25.9%</td>
<td>7.4%</td>
<td>3.7%</td>
<td>3.7%</td>
<td>7.4%</td>
<td>7.4%</td>
<td>29.6%</td>
</tr>
<tr>
<td>Upper extremity frac or inj. (N=46)</td>
<td>32.6%</td>
<td>15.2%</td>
<td>4.3%</td>
<td>17.3%</td>
<td>6.5%</td>
<td>13.0%</td>
<td>39.1%</td>
</tr>
</tbody>
</table>
In Table 5 we see that BH (13.5%) and PsH (12.3%) were the health aspects where participants most frequently experienced a negative impact. 86.6% and 88.6% respectively considered their worsened BH and PsH to be related to the crash. 17.5% of the participants replied to have PPC following the accident and 28% reported that the injury led to an RPF, 50% of whom reported to still suffer from RPF, today. The most common reasons being joint issues and related mobility issues in the wrist, ankle, shoulder, elbows and knees, but also spinal and neck issues resulting in headaches. The latter also matches well that 17.8% complained to been bothered by bodily aches and pains in the past six months, in the stress/anxiety checklist, and considered this to be related to the crash. In total, 62% of the participants marked to have been bothered by at least one stress symptom in the past 6 months, with 1 stress marker being the fewest, 23 the most markers checked off by a single individual and an average of 4.3 stress markers per participant.

Almost 50% of these participants, felt that the experienced stress/anxiety symptoms are related to the crash and 33.5 % report the crash to have caused pre-existing stress/anxiety symptoms to worsen.

### 3.2.3 Economic health aspect

On the change in their economic situation (Econ) compared to before the accident, few (1.7%) consider any negative impact to be related to the crash. Meanwhile, 12.5% considered a decrease of working capacity (not work full time, compared to before the accident), to be related to the crash.
3.2.4 Social health and leisure time aspects

As seen in table 5, leisure time pleasure is the health aspect that is the most negatively impacted following bicycle crashes. 7.5% of participants consider their worsened leisure time pleasure to be related to the crash. Regarding contact to others and family respectively 4.8% and 2.0% report a negative impact and consider it related to the crash. Especially the people who suffered internal and/or torso injuries as well as upper extremity injuries seem to experience worsened contact, as seen in Table 6.

3.2.5 Cycling habits

Regarding the cycling habits since the crash in Table 5 we see that 73.4% stated that their habits were unchanged, while 11.6% reported increased bicycle use and 14.0% reported a decrease. Overall 28.5% consider their current cycling habits to be related to suffering a crash, of whom 41.2% reported to cycle less, 46% had unchanged cycling habits and 12.8% cycled more than prior to the crash.

4 DISCUSSION

Based on a survey among people recently involved in bicycle crashes, this study explores the impacts on the health-related quality of life associated to accidental injuries following the crashes. The results show that 27.3% suffer negative impacts on their health-related quality of life compared to before their crash, 78% of whom consider this to be related to the injury. The results show that several health aspects suffer negative impacts following the bicycle crashes with the most frequently reported aspects being the physical and psychological health, and that extremity and head injuries/fractures are the most related to these outcomes. This is in line with previous studies, where psychological and physical impacts also tend to dominate the HRQoL related impacts of road traffic accident related injuries (Ohlin et al., 2017; Tournier et al., 2014).

Meanwhile, the results also show that one health aspect being impacted does not necessarily
indicate all health impacts being impacted. This is seen as 27% of the participants reported
impacted HRQoL, while the most impacted health aspect was the physical one, being impacted
among 11.5% of the participants. The addition of the question regarding amount of cycling that
the participants do compared to before the incident, while not directly related to the HRQoL,
still has a major impact on future personal and societal health. The fact that almost 25% relate
a non-increase or decrease of the cycling they do to their crash involvement is detrimental, given
the positive aspects of related to the physical activity it yields (Mueller et al., 2015).

An additional contribution of this study is achieved through the use of the Late Effect of
Accidental Injury Questionnaire. By including the participant’s opinion on the relation between
crash involvement and the experienced changes in health, this questionnaire enables the
separation of accident and non-accident related change. This is an important contribution when
comparing to generic health surveys, such as the EQ-5D, where no such separation is attempted
and thus allows for potential “noise” in the reported results. However, it has to be noted that in
our sample around 80% or more of the participants reporting negative impacts on health aspects
related this impact to being in a bicycle crash.

One difference of this study in comparison to studies such as (Hours et al., 2010; Khati et al.,
2014; Mayou & Bryant, 2003) was the use of an online survey not based on national/regional or
hospital registries. This means that we could not, with medical certainty, score the injury
severities using AIS system. However, the participants did report the duration in which they felt
ailed by the injury directly.

52% percent of the participants indicated that ailments lasted less than a month following the
crashes, 65% of whom stated to have suffered ailments 1 week or less. This could indicate that
our sample contains rather many minor injuries, which is supported by the fact that only 47% of
the participants even sought medical attention. When comparing to a study such as such as Polinder et al. (2015), head injuries in this study were rather rare. However, even among these participants some report impacted HRQoL aspects, which supports the need to not neglect the focus of minor injuries (McClure & Douglas, 1996). An investigation of the specific frequency of impacted health aspects in contrast to “injury severity” would have to be conducted for additional insight on this.

Lastly an interesting aspect of the Questionnaire that was employed reveals that some participants consider some of the positive impacts compared to before the crash to be related to the actual crash. This is a rather interesting and surprising result, but in the meantime also not entirely unimaginable. It could be stipulated that such a relation is due to new habits being obtained following rehabilitation work or similar.

5 CONCLUSION

- 27.3 % percent report at least one negatively impacted health aspect, 78% of whom consider this to be related to the crash.
- The use of the LEAIQ allows us to distinguish between negatively impacted health aspects related to, and not related to the accidental injuries.
- Physical and Psychological health consequences are the health aspects most often related to a negative health impact following bicycle crashes.
- Head and extremity injuries and fractures are the injury types most often related to negative health impacts.

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