Mental health and other factors associated with work productivity post injury in the UK: multicentre cohort study

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What is already known on this subject

Unintentional injuries result in delays in returning to work, time off work and productivity loss.

Mental health problems are common after unintentional injury and are key contributors to productivity loss.

Few studies have explored the mental health sequalae of injuries on productivity loss.

What this study adds

Unintentional injuries resulted in 3.3% of working time lost due to reduced productivity 2 months after injury, 1.7% at 4 months and 1% at 12 months.

Work limitations were most marked for physical and time management demands and these took longer to improve than mental and output demands.

Females, those with history of psychiatric conditions prior to injury and symptoms of post-traumatic distress experienced greater productivity loss and may require additional support to enable successful return to work.

Abstract

Introduction: Mental health conditions are a major contributor to productivity loss and are common post-injury. This study quantifies post-injury productivity loss and its association with pre and post-injury mental health, injury, demographic, health, social and other factors.

Methods: Multi-centre, longitudinal study recruiting hospitalised 16-69-year-old employed individuals with unintentional injuries, followed-up at 1,2,4 and 12 months. Participants completed questionnaires on injury, demographic factors, health (including mental health), social factors, other factors and on-the-job productivity upon return to work (RTW). Odds ratios were estimated for above median productivity loss, using random effects logistic regression.

Results: 217 adults had made a RTW at 2,4 or 12-months post-injury: 29% at 2-months, 66% at 4-months, and 83% at 12-months. Productivity loss reduced over time: 3.3% of working time at 2-months, 1.7% at 4-months, 1% at 12-months. Significantly higher productivity loss was associated with pre-injury psychiatric conditions (OR 21.40, 95% CI: 3.50, 130.78) and posttraumatic stress avoidance symptoms at 1-month (OR for one-unit increase in score 1.15, 95%CI 1.07, 1.22). Significantly lower productivity loss was associated with male gender (OR 0.32, 95%CI 0.14, 0.74), upper and lower limb injuries (vs other body regions, OR 0.15, 95% CI: 0.03, 0.81), and sports injuries (vs. home, OR 0.18, 95% CI: 0.04, 0.78). Pre-injury psychiatric conditions and gender remained significant in analysis of multiply imputed data.

Conclusions: Unintentional injury results in substantial productivity loss. Those with pre-injury psychiatric conditions, females and posttraumatic stress avoidance symptoms experience greater productivity loss and may require additional support to successfully RTW.

Introduction

Unintentional injuries are common amongst working age adults in the United Kingdom (UK), with more than 304,000 hospital admissions in 16-64 year olds in England in 2019/20.[1] They can result in substantial delays in returning to work post-injury, time off work and productivity loss.[2-4] For example, among working age adults, only 67% of adults had made a return to work (RTW) 12-months after being admitted to hospital in England following an unintentional injury.[2] Productivity loss resulting from decreased on-the-job productivity or employee absence [5-6] has substantial societal[5], employer[3] and individual[4] costs. A recent systematic review of the socioeconomic impact of orthopaedic trauma found most studies report productivity loss in relation to absenteeism, reduced hours of work or financial losses post-injury.[6] However, productivity losses associated with injury can continue beyond the first RTW, through further injury-related sickness absence or impairments reducing on-the-job productivity.[7]

To our knowledge, few studies report on-the-job productivity losses post-injury. One UK study in a general injury population reported up to 4.6% of productive working time was lost at 4-months post-injury[8]. A New Zealand study reported 3.6% of productive working time was lost 4 years after mild traumatic brain injury.[9] Another study estimated the limitations of work performance to be 20-25% of the time at 84 months following severe lower extremity injury.[10] The degree of injury-related productivity losses were slightly less than those reported for brain tumour survivors,[11,12] and those with rheumatoid arthritis,[13] but substantially less than for those with depression and anxiety.[14]

Mental health conditions are key contributors to productivity loss,[15] and conditions such as depression, anxiety and post-traumatic distress disorder (PTSD) are common post-injury.[16] These often co-exist with pain and injury-related physical problems,[17] which may also reduce productivity. Despite this, reviews have found few studies exploring the impact of injuries and their mental health sequalae on productivity after returning to work.[18] One very small Canadian study reported employees with chronic PTSD (only 30% of whom had PTSD resulting from unintentional injuries) had impaired work performance in terms of time management, output and mental-interpersonal demands with productivity losses similar in magnitude to those for major depression.[19]

Given the high productivity losses associated with mental health conditions and the high prevalence of these problems pre and post-injury, we used data from The Impact of Injuries Study[20] to explore a) productivity loss post-injury, b) how mental health pre and post-injury impacts on productivity after making a RTW and c) the injury, demographic, health, social and other factors associated with productivity loss in a hospitalised injury population.

Methods

Study design, setting and context

The study is part of the Impact of Injuries Study; a longitudinal multi-centre study recruiting participants admitted to hospital with a wide range of unintentional injuries from 4 UK study centres (Nottingham, Leicester/Loughborough, Bristol, and Surrey). In the UK health services are free for all nationals. Employees (but not the self-employed) are entitled to Statutory Sick Pay (£96/week) for the first 28 weeks of sickness absence. Different employers also have different sick pay policies determining the amount and duration of sick pay. Some

individuals may also have sickness insurance which provides variable levels of payment during sickness absence. Unlike some countries, there is no national injury or workers compensation scheme. Detailed study methods are published elsewhere.[20] A Patient and Public Involvement member was involved in the design and conduct of this research.

Participants

Participants were recruited within three weeks of hospital admission for unintentional injury (i.e. self-reported as accidental injury at time of recruitment) between June 2010 and June 2012. Patients were excluded if they were <16 or >70 years old at injury, did not have a fixed address (due to inability to follow-up), or had loss of consciousness, amnesia or Glasgow coma scale <15 at presentation due to difficulty distinguishing between head injury sequelae and psychological morbidity.[21] Participants were recruited by research staff face-to-face in hospital or by post/phone following hospital discharge, and followed up via post, email or phone based on preference. All participants provide written informed consent. Analyses presented here were restricted to participants employed at recruitment, returning the 1-month questionnaire, and reporting RTW on at least one follow-up questionnaire at 2, 4, or 12-months post-injury.

Questionnaires

Participants completed questionnaires at recruitment assessing injury circumstances, socio-demographic characteristics and pre-injury health status, quality of life and occupational details, including: Hospital Anxiety and Depression Scale (HADS), Alcohol Use Disorder Identification Test (AUDIT), Drug Abuse Screening Test (DAST), Social Functioning

Questionnaire (SFQ) and 8-item Work Limitations Questionnaire (WLQ) (described and referenced in table 1). Area-level deprivation was measured with the Index of Multiple Deprivation (IMD) 2010.[22] Participants completed a shortened structured clinical interview (SCID)[23] with a researcher to determine psychiatric conditions in the 2 years prior to injury (subsequently referred to as pre-injury psychiatric conditions). Medical record data were used to derive the Abbreviated Injury Scale (AIS)[24] to measure injury severity, categorised as minor (AIS=1), moderate (AIS=2) and serious to maximum (AIS=3-6) based on the most severe injury for participants with multiple injuries.

Follow-up questionnaires at 1, 2, 4 and 12-months post injury included the scales in the baseline questionnaire, plus questions on time off work since injury, self-reported recovery,[25] visual analogue pain scale, stressful life events (List of Threatening Experiences[26]), legal proceedings or compensation claims due to injury. In addition, participants completed: Impact of Events Scale (IES), Social Functioning Scale (SFQ), Crisis Support Scale (CSS) and Change in Outlook Questionnaire, (CiOQ) (described and referenced in table 1). Participants scoring above threshold values on follow-up questionnaires on the HADS depression (>7), HADS anxiety (>7), IES (>18 for each subscale or >29 for combined scores), AUDIT (>7) or DAST (>2) scales had a shortened SCID interview administered by a researcher.

Table 1: Description of scales used in the study.

Construct being measured	Measurement time points (months)	Scale used	Description of scale	Internal consistency/reliability	Citations reporting internal consistency/reliability
Anxiety and Depression	0,1,2,4,12	Hospital Anxiety and Depression Scale (HADS)	Measure consists of 7 items measuring depression and 7 items measuring anxiety. Scores range from 0 to 21 for each subscale. Higher scores indicate higher severity of anxiety and depression.	Cronbach's alpha ranges from 0.68-0.93 (anxiety) and 0.67-0.90 (depression) across varying populations.	Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale: An updated literature review. Journal of Psychosomatic Research. 2002; 52:69-77.
Alcohol use	0,1,2,4,12	Alcohol Use Disorder Identification Test (AUDIT)	Measure consists of 10 items measuring alcohol use. Scores range from 0 to 40. Higher scores indicate higher levels of excessive or harmful drinking.	Cronbach's alpha ranges from 0.75-0.94 across varying populations.	Allen JP, Litten RZ, Fertig JB, Babor T. A review of research on the Alcohol Use Disorders Identification Test (AUDIT). Alcohol Clin Exp Res. 1997; 21:613-9.
Substance use	0,1,2,4,12	Drug Abuse Screening Test (DAST)	Measure consists of 10 items measuring drug use. Scores range from 0-10. Higher scores indicate higher levels of abuse of substances other than alcohol.	Cronbach's alpha 0.86 in psychiatric outpatients; 0.94 in newly admitted psychiatric inpatients.	Yudko E, Lozhkina O, Fouts A. A comprehensive review of the psychometric properties of the Drug Abuse Screening Test. J Subst Abuse Treat. 2007; 32:189-98.
Social functioning	0,1,2,4,12	Social Functioning Questionnaire (SFQ)	Measure consists of 8 items measuring social functioning. Score ranging from 0 to 24. Higher scores indicate greater social dysfunction	Cronbach's alpha 0.72 in injured adults.	Kendrick D, Dhiman P, Kellezi B, Coupland C, Whitehead J, Beckett K, et al. Psychological morbidity and return to work after injury: multicentre cohort study. Br J Gen Pract. 2017; 67:e555-e64.
Work limitations	0,1,2,4,12	8-Item Work Limitations Questionnaire (WLQ)	Measure consists of 8 items measuring the amount of time subjects experienced difficulty with job performance across 4 domains: Time, Physical,	Reliability (estimated from confirmatory factor analysis) 0.69 in university employees.	Walker TJ, Tullar JM, Diamond PM, Kohl HW, 3rd, Amick BC, 3rd. Validity and Reliability of the 8-Item Work Limitations Questionnaire. J Occup Rehabil. 2017; 27:576-83.

			Mental-Interpersonal, and Output Demands. Responses measured on a 5 point scale ranging from all of the time (100%) to none of the timel (0%) for items applicable to their job. The responses were combined across domains to produce a productivity loss score representing the percentage of productive working time lost due to a health condition compared to a healthy employee using the method developed by Lerner and colleagues. The score can range from 0% to 100%.		
Post-traumatic distress	1,2,4,12	Impact of Events Scale (IES)	Measure consists of 7 items measuring intrusion and 8 measuring avoidance symptoms. Scores range from 0 to 75 overall. Higher scores indicate higher severity of post-traumatic symptoms.	Cronbach's alpha ranges from 0.72–0.92 (intrusion) and 0.65–0.90 (avoidance) across varying populations.	Sundin EC, Horowitz MJ. Impact of Event Scale: psychometric properties. Br J Psychiatry. 2002; 180:205-9.
Social support	1,2,4,12	Crisis Support Scale (CSS)	Measure consists of 6 items measuring social support. Scores range from 6-42. Higher scores indicate higher social support.	Cronbach's alpha 0.82 from data combined across 11 studies with varying populations.	Elklit A, Pedersen S, Jind L. The Crisis Support Scale: Psychometric qualities and further validation. Personality and Individual Differences. 2001; 31:1291-302.
Positive and negative changes in outlook	1,2,4,12	Changes in Outlook Questionnaire, (CiOQ)	Measure consists of 5 items measuring positive changes and 5 items measuring negative changes. Scores range	Cronbach's alpha ranges from 0.76-0.78 (positive changes) and 0.82-0.83 (negative changes) in	Joseph S, Alex Linley P, Shevlin M, Goodfellow B, Butler LD. Assessing Positive and Negative Changes in the Aftermath of Adversity: A Short Form of

			from 5 to 30 for each subscale. Higher scores indicate greater positive and negative changes respectively.	college students and trauma support organisation members.	the Changes in Outlook Questionnaire. Journal of Loss and Trauma. 2006; 11:85-99.
Pain	0,1,2,4,12	Visual Analogue Pain Scale (VAS)	VAS measures the self-rated pain intensity on a vertical visual analogue scale ranging from no pain to the worst pain imaginable (0-100).	Correlates highly with other pain measures.	Hawker, G.A., Mian, S., Kendzerska, T. and French, M. (2011), Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res, 63: S240-S252. https://doi.org/10.1002/acr.20543

Outcome

A work limitation productivity loss score was calculated from the Work Limitations Questionnaire[27] for participants who had made a RTW at each follow-up time point (2, 4, and 12-months). RTW was defined as being in full- or part-time paid employment, working at the specific time point, and not being prevented from working since the previous follow-up because of the injury sustained. The productivity loss score represents the percentage of productive working time lost due to a health condition compared to a healthy employee, [28] and can therefore range from 0% to 100% (see table 1 for more details). The score was dichotomised at the median at each time point because model assumptions were not for met for linear regression using the score as a continuous variable.

Statistical Analysis

Baseline characteristics were compared between participants employed at recruitment, returning the 1-month questionnaire and returning one or more subsequent questionnaires (i.e. responders included in the analysis) and those not returning subsequent questionnaires (i.e. non-responders excluded from the analysis) to explore characteristics associated with loss to follow-up. Chi-square tests were used to compare categorical data and t-tests or Mann-Whitney U tests for continuous data, dependent on distributions.

Odds ratios with 95% confidence intervals were estimated for having higher than average productivity loss (i.e. above median), using random effects logistic regression to account for repeated measures of work limitations at 2, 4, and 12-months. Participants were included in the analysis for the time points at which they were in work, hence the analysis encompassed

a range of RTW trajectories. Analyses included univariate and multivariable regression models. The number of observations in each analysis are given in tables 2-4. These vary due to missing data. The stages of model building and the factors considered for inclusion in each model are described in Box 1.

Box 1. Multivariable model building for factors associated with productivity loss.

Stages of model building:

1. Model A included a-priori confounders.

2. Model B added mental health factors measured at 1-month individually to Model A, in order of statistical significance in univariate analysis. Mental health factors remained in Model B if the likelihood ratio test p-value was <0.05.

3. Correlations between factors to be added in Model C and D (below) were assessed with the mental health factors in Model B. Factors were excluded if correlations were ≥0.5 or ≤-0.5.

4. Model C added baseline factors as a block to Model B. These factors were individually removed using a step-wise procedure if the likelihood ratio test p≥0.05 and removal resulted in <10% change in associations for mental health factors added in Model B.

5. Model D added heath, social and other factors measured at 1-month as a block to Model C. Factors were then removed as for Model C.

Factors considered for inclusion in each model:

Model A (a-priori confounders): age, sex, study centre, and follow-up time.

Model B (mental health factors measured at 1-month): HADS depression (HADS-D), HADS anxiety (HADS-A), IES avoidance (IES-A), IES intrusion (IES-I), AUDIT and DAST.

Model C (baseline factors): number of pre-injury psychiatric conditions, HADS-D, HADS-A, AUDIT, DAST, long standing illness, ethnic group, deprivation (IMD), marital status, length of hospital stay, injury severity, number of injuries, body part injured, injury mechanism, and injury location (home, road, work etc.).

Model D (health, social and other factors measured at 1-month): social functioning, social support, changes in outlook (positive and negative), life events since injury, pain visual analogue scale, compensation, and litigation.

Interactions between mental health factors at 1-month and age, sex, and time were assessed by adding interaction terms to the final model ($p<0.01$). Collinearity between factors was assessed by the covariance correlation matrix and variance inflation factors. Model assumptions were checked using deviance residuals. Conditional multiple imputation with chained equations imputed missing data for participants employed at recruitment who had RTW at the respective time point, including imputing missing data items for responders and imputing data for non-responders. Ten datasets were created and combined using Rubin's rules.[29] The number of hours lost per week due to productivity losses were calculated by multiplying the average UK working week of 37.6 hours[26] by the percentage of productive working time lost for each participant, then dividing the total hours lost for all participants by the number of participants at each time point.

Results

Data was collected from 668 participants at baseline, 393 (59%) of whom were employed at the time of injury. Of these 299 (76%) returned the 1-month follow-up questionnaire, and 217 (73%) of these were included in the analysis because they reported that they had made a RTW at 2, 4 or 12-months. Figure 1 shows participant flow through the study.

[INSERT FIGURE 1]

Table 2 shows study participants were predominantly of white ethnic background (98%); 54% were aged 45-64 years, and 52% were male. Participants stayed a median of 5 nights in hospital post-injury; most (77%) had a moderate severity injury, just under half (45%)

reported single injuries and three-fifths (61%) had lower limb injuries. Three-fifths (60%) were injured during a fall, and 28% were injured at work.

Table 2 Baseline characteristics of study participants

Characteristics	Participants who were employed at recruitment, returned 1-month questionnaire, and had returned to work at either 2, 4, or 12-months (n=217)
Centre	
Nottingham	77 (35.5)
Loughborough	58 (26.7)
Bristol	56 (25.8)
Surrey	26 (12.0)
Age	
16-24	22 (10.1)
25-44	73 (33.6)
45-64	117 (53.9)
65+	5 (2.3)
Sex	
Female	105 (48.4)
Male	112 (51.6)
Number of pre-injury psychiatric conditions (SCID)	
0	191 (88.0)
1	21 (9.7)
≥2	5 (2.3)
Pre-injury productivity loss	[12]
Median (IQR)	0 (0, 1.8)
Pre-injury HADS-D scale	[1]
Median (IQR)	0 (0, 2)
Pre-injury HADS-A scale	[1]
Median (IQR)	2 (0, 4)
Pre-injury AUDIT scale	[2]
Median (IQR)	4 (2, 7)
Pre-injury DAST scale	[1]
Median (IQR)	0 (0, 0)
Pre-injury social functioning scale	
Median (IQR)	2 (0, 3)
Pre-injury pain visual analogue scale	
Median (IQR)	0 (0, 1)
Long standing illness	[1]

No	186 (85.7)
Yes	30 (13.8)
Ethnic group	
White	212 (97.7)
BME	5 (2.3)
Deprivation (IMD)	[2]
Median (IQR)	12 (7, 19)
Marital status	
Single	53 (24.4)
Married/partnership	135 (62.2)
Divorced/widowed	29 (13.4)
Nights in hospital	[8]
Median (IQR)	5 (3, 8)
Injury severity*	[1]
Minor (AIS = 1)	12 (5.5)
Moderate (AIS = 2)	168 (77.4)
Serious or worse (AIS = 3-6)	36 (16.6)
Number of injuries	
1	98 (45.2)
2	74 (34.1)
≥3	45 (20.7)
Body part injured	
Other	22 (10.1)
Upper limb	43 (19.8)
Lower limb	133 (61.3)
Upper and lower limbs	19 (8.8)
Injury mechanism	
Other	21 (9.7)
Falls	131 (60.4)
Traffic	46 (21.2)
Struck	19 (8.8)
Place of injury	[1]
Home	35 (16.1)
Work	33 (15.2)
Road	61 (28.1)
Countryside	25 (11.5)
Sports facilities	31 (14.3)
Other	31 (14.3)

[ ] missing values. SCID= structured clinical interview; HADS-D=HADS depression; HADS-A= HADS anxiety; AUDIT=alcohol use disorder identification test; DAST=drug abuse screening test; IMD = Index of Multiple Deprivation. *Injury severity measured using the Abbreviated Injury Scale (AIS); minor = AIS=1, Moderate = AIS=2, Serious or worse = AIS>3.

Online table 1 compares baseline and 1-month characteristics between responders and non-responders to follow-up questionnaires. Non-responders had significantly greater alcohol and drug use than responders and lived in more disadvantaged areas but were otherwise similar to responders.

Less than one-third (29%) of participants had made a RTW at 2, 66% at 4, and 83% at 12-months (figure 1). Productivity losses were highest at 2-months post recruitment and reduced over time. Median (IQR) productivity loss scores at 2, 4 and 12-months were 3.3% (0-6.7%), 1.7% (0-4.3%) and 1.2% (0-4.2%) respectively. Assuming an average UK working week of 37.6 hours (26), for each participant who had made a RTW this equates to an average of 1.4 hours lost per week (70.5 hours lost for 51 participants) at 2-months, 1 hour lost per week (110.7 hours lost for 108 participants) at 4-months and 1 hour lost per week (135.3 hours for 136 participants) at 12-months. Over the course of a year, based on losing one hour of productive time per week and 5.6 weeks annual leave per year[30], this equates to 1.2 weeks of productive working time lost per injured participant. Figure 2 shows productivity loss scores over time and the percentage of time work was limited for each of the domains (time management demands, physical demands, mental demands, and output demands). Of the 4 domains, there were greater limitations in time management and physical demands, and these were slower to improve than limitations in mental and output demands.

[INSERT FIGURE 2]

Univariate associations with productivity loss are presented Table 3. The odds of higher than average productivity loss were greater for those with higher depression scores at 1-month post-injury (27% increase per unit increase in depression score; OR 1.27, 95% CI: 1.13, 1.44) and anxiety scores at 1-month post-injury (26% increase per unit increase in anxiety score; OR 1.26, 95% CI: 1.13, 1.40). The odds of higher than average productivity loss were also greater for those with greater symptoms of posttraumatic distress at 1-month post-injury indicated by higher IES-A scores (15% increase per unit increase in IES-A score; OR 1.15, 95% CI: 1.08,1.23) and higher IES-I scores (11% increase per unit increase in IES-I score; OR 1.11, 95% CI: 1.05,1.17). Those suffering stressful life events (OR 8.44, 95% CI: 1.74, 41.01) and greater levels of pain (odds ratio for a one unit increase in pain scale: OR 1.03, (5% CI: 1.01, 1.05) in the month post-injury also had greater odds of higher than average productivity loss

Table 3 Unadjusted odds ratios for potential factors associated with higher productivity loss across all time points*

Variables	**Unadjusted OR (95% CI) n=179**
A-priori confounders	
Centre	
Nottingham	1.00
Loughborough	0.87 (0.33, 2.28)
Bristol	1.29 (0.47, 3.55)
Surrey	0.53 (0.15, 1.87)
Age	
16-24	1.00
25-44	0.95 (0.26, 3.51)
45-64	1.70 (0.47, 6.17)
65+	1.09 (0.06, 20.21)
Sex	
Female	1.00
Male	0.32 (0.15, 0.72)
Time	
2 months	1.00
4 months	0.63 (0.24, 1.64)
12 months	0.53 (0.19, 1.48)

Mental health factors at 1-month post-recruitment	
HADS-D scale	1.27 (1.13, 1.44)
HADS-A scale	1.26 (1.13, 1.40)
IES-A scale	1.15 (1.08, 1.23)
IES-I scale	1.11 (1.05, 1.17)
AUDIT scale [1]	0.91 (0.81, 1.01)
DAST scale [1]	0.81 (0.37, 1.76)
Health, demographic and injury factors at recruitment	
Number of pre-injury psychiatric conditions (SCID)	
None	1.00
≥1	15.19 (2.87, 80.51)
HADS-D scale	1.20 (0.98, 1.49)
HADS-A scale	1.16 (1.01, 1.32)
AUDIT scale [2]	0.93 (0.83, 1.03)
DAST scale [1]	1.03 (0.45, 2.36)
Long standing illness [1]	
No	1.00
Yes	3.63 (1.06, 12.43)
Ethnic group	
White	1.00
BME	8.21 (0.39, 172.72)
Deprivation (IMD) [2]	1.02 (0.99, 1.05)
Marital status	
Single	1.00
Married/partnership	1.28 (0.51, 3.17)
Divorced/widowed	1.47 (0.38, 5.67)
Nights in hospital [7]	1.04 (0.95, 1.14)
Injury severity** [1]	
Minor (AIS = 1)	1.00
Moderate (AIS = 2)	1.59 (0.34, 7.52)
Serious or worse (AIS = 3-6)	1.62 (0.27, 9.68)
Number of injuries	
1	1.00
2	1.03 (0.43, 2.45)
≥3	1.49 (0.53, 4.20)
Body part injured	
Other	1.00
Upper limb	0.31 (0.07, 1.34)
Lower limb	0.63 (0.18, 2.23)
Upper and lower limbs	0.24 (0.04, 1.53)
Injury mechanism	
Other	1.00
Falls	0.94 (0.27, 3.33)
Traffic	1.80 (0.42, 7.65)
Struck	1.23 (0.22, 6.74)
Place of injury [1]	

Other	1.00
Home	1.64 (0.44, 6.09)
Work	1.38 (0.47, 4.00)
Road	1.29 (0.34, 4.92)
Countryside	0.26 (0.07, 0.99)
Sports facilities	1.73 (0.48, 6.26)
Health, social and other factors at 1-month post-recruitment	
Social functioning scale	1.26 (1.12, 1.42)
CSS scale [1]	0.89 (0.83, 0.96)
CiOQ-P [1]	1.09 (1.03, 1.16)
CiOQ-N [1]	1.22 (1.10, 1.34)
Life events since injury [1]	
No	1.00
Yes	8.44 (1.74, 41.01)
Pain visual analogue scale	1.03 (1.01, 1.05)
Seeking compensation [4]	
No	1.00
Yes	2.11 (0.76, 5.87)
Involved in litigation [1]	
No	1.00
Yes	1.76 (0.53, 5.81)

[ ] missing values. SCID= structured clinical interview; HADS-D=HADS depression; HADS-A=HADS anxiety; IES-A=IES avoidance; IES-I=IES intrusion; AUDIT=alcohol use disorder identification test; DAST=drug abuse screening test; IMD = Index of Multiple Deprivation; CSS=Crisis Social Support; CiOQ-P=Change in outlook questionnaire (positive); CiOQ-P=Change in outlook questionnaire (negative). *Higher work limitations = above median of WLQ productivity loss scale. **Injury severity measured using the Abbreviated Injury Scale (AIS); minor = AIS=1, Moderate = AIS=2, Serious or worse = AIS>3.

Table 4 presents the multivariable regression models. In the final model participants with a pre-injury psychiatric condition had a 21-fold increased odds of higher than average productivity loss (OR 21.40, 95% CI: 3.50, 130.78) than those without. A one-unit increase in the IES-A score at 1-month increased the odds of higher than average productivity loss by 15% (OR 1.15, 95% CI: 1.07, 1.22). Having both upper and lower limbs injured reduced the odds of higher than average productivity loss by 85% compared to injuries in other body regions (OR 0.15, 95% CI: 0.03, 0.81). Injuries occurring at sports facilities reduced the odds of higher than average productivity loss by 82% compared to those occurring at home (OR 0.18, 95% CI: 0.04, 0.78). The odds of higher than average productivity loss were lower in

males than females (OR 0.32, 95% CI: 0.14, 0.74). None of the additional factors in model D was statistically significant, hence model C is the final model. There were no significant interactions between IES-A score and age, sex, and time. Variance inflation factors ranged from 1.11 to 3.65.

Table 4 Adjusted odds ratios for baseline and 1-month post-recruitment predictors of higher productivity loss across all time points*

Characteristics	**Model A: A-priori confounders (n=179)**	**Model B: Model A + mental health factors at 1-month (n=179)**	**Model C: Model B + health, demographic and injury factors at recruitment ** (n=175)**
	Odds Ratio (95% CI)	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
A-priori confounders			
Centre			
Nottingham	1.00	1.00	1.00
Loughborough	1.00 (0.35, 2.86)	1.30 (0.50, 3.40)	2.03 (0.81, 5.11)
Bristol	1.17 (0.39, 3.47)	1.14 (0.42, 3.11)	1.02 (0.42, 2.47)
Surrey	0.49 (0.13, 1.88)	0.66 (0.19, 2.26)	1.07 (0.35, 3.24)
Age			
16-24	1.00	1.00	1.00
25-44	1.10 (0.28, 4.31)	2.43 (0.67, 8.86)	3.51 (0.98, 12.60)
45-64	1.94 (0.49, 7.67)	3.99 (1.05, 15.18)	2.90 (0.83, 10.11)
65+	0.99 (0.05, 20.11)	2.43 (0.16, 36.73)	4.88 (0.37, 64.22)
Sex			
Female	1.00	1.00	1.00
Male	0.32 (0.13, 0.76)	0.33 (0.14, 0.74)	0.32 (0.14, 0.74)
Time			
2-months	1.00	1.00	1.00
4-months	0.60 (0.23, 1.58)	0.65 (0.25, 1.68)	0.67 (0.26, 1.76)
12-months	0.52 (0.18, 1.46)	0.55 (0.20, 1.51)	0.52 (0.18, 1.48)
Mental health predictors at 1-month post-recruitment			
IES-A scale		1.18 (1.09, 1.26)	1.15 (1.07, 1.22)
Psychological, socio-demographic, and injury characteristics at recruitment			
Injured body part			
Other			1.00
Upper			0.41 (0.12, 1.38)
Lower			0.90 (0.29, 2.76)
Both			0.15 (0.03, 0.81)

Injury mechanism	
Other	1.00
Falls	0.71 (0.23, 2.14)
Traffic	4.08 (0.85, 19.57)
Struck	1.52 (0.33, 7.11)
Place of injury	
Home	1.00
Work	3.13 (0.91, 10.76)
Road	0.64 (0.19, 2.15)
Countryside	1.17 (0.35, 3.88)
Sports facilities	0.18 (0.04, 0.78)
Other	1.29 (0.39, 4.23)
Number of pre-injury psychiatric conditions (SCID)	
None	1.00
≥1	21.4 (3.50, 130.78)

*Higher work limitations = above median of WLQ productivity loss scale. **Model C and D are the same model; no other predictors at 1 month were retained in the final model. IES-A=IES avoidance. SCID=structured clinical interview.

Analysis of multiply imputed data (online table 2) showed that only gender and pre-injury psychiatric conditions remained significantly associated with higher than average productivity loss (OR males vs. females 0.31, 95% CI: 0.17, 0.90; OR for pre-injury psychiatric conditions vs. none 14.60, 95% CI: 3.02, 70.67).

Discussion

Main findings

Our study shows hospitalised unintentional injuries impact substantially on work, both in terms of absenteeism and on-the-job productivity loss. Amongst those who had made a RTW at some point during the first 12 months after their injury, one third had not returned 4 months after injury and one sixth had not returned 12 months after injury, indicating non-sustainability of RTW for some participants. On-the-job productivity, measured using the

Work Limitations Questionnaire[31], was reduced after returning to work, particularly in relation to time management and physical demands. Reductions in productivity improved between 2- and 4-months post-injury, but then remained stable until 12-moths post injury, suggesting some long-lasting productivity loss. Female gender, pre-injury psychiatric conditions and post-traumatic distress symptoms were associated with significantly greater productivity loss. We did not find significant associations between any other injury, demographic, health (including mental health), social or other factors (compensation or litigation) and productivity loss. Sports injuries and injuries to both upper and lower limbs were associated with lower productivity loss in the complete case analysis; however, these associations were not statistically significant in the analysis of multiply imputed data.

Strengths and Limitations

This is one of very few studies reporting on-the-job productivity losses amongst working-age adults suffering a wide range of unintentional injuries. Our study recruited from four sites in England, providing trauma services to populations varying in terms of deprivation and rurality. We measured a wide range of factors potentially associated with productivity loss, including psychological morbidity and psychosocial factors, not measured in the only previous study reporting productivity loss in a similar population of injured adults.[8] Our study had a high follow-up rate, but non-responders had significantly greater problems with alcohol and drug use than responders and lived in more disadvantaged areas. Our finding that gender and history of psychiatric conditions remained strongly associated with productivity loss were robust to missing data, however the associations between posttraumatic distress avoidance symptoms body part injured, place of injury and productivity loss did not remain statistically significant in analysis of multiply imputed data.

The WLQ is based on self-reported work limitations. Systematic reviews highlight the limitations of work limitation measurement tools,[32-33] but the WLQ was found to have moderately strong positive evidence for content and structural validity.[32] Self-reported work limitations may be biased if employees over-report productivity, but there is some evidence that productivity loss measured with the WLQ is at least moderately correlated with employer productivity metrics.[34-35]

Our study sample represents a heterogeneous group of injuries resulting in differing functional impacts, limiting work to varying degrees, depending on the tasks required for individual jobs. Our study did not measure organisational factors which may be associated with productivity loss, such as organisational policies (e.g. sickness pay, absence monitoring, types of contract), job design features (control over job adjustment) or workplace culture.[36] The relatively small sample size and small numbers of patients with some characteristics (e.g. pre-injury psychiatric conditions, occupational injuries, ethnic group) has resulted in wide confidence intervals or a lack for power to detect associations with productivity loss for some characteristics, and this should be borne in mind when interpreting our findings.

Comparisons with other studies

Work productivity losses are similar to those found in a previous UK study reporting data from a general injury population.[8] Productivity losses in the first 2-months post-injury are higher than those in overweight and obese workers (2%),[37] similar to those in workers with rheumatoid arthritis (4.9%)[13] but lower than in workers with brain tumours (5.6%

and 6.2%),[11,12] musculoskeletal conditions (8.7%),[14], arthritis and rheumatism (8.6%),[14] major depression (7.2% and 11.4%)[38,39] or chronic PTSD (12.9%).[19]

Our finding of a higher odds of productivity loss in those with a history of psychiatric condition is consistent with a previous UK study which found those with pre-existing long standing illnesses at the time of injury had lower productivity on RTW post-injury.[6] Our finding of greater productivity loss in females differs from a previous study which found no gender differences in productivity loss; however this may have been due to this study including depression and gender in the same regression model.[39] Possible explanations for the significant results in our study include gender differences in occupations, work-life balance, inequalities or discrimination that women face in the labour market.[40] Further research is required to confirm our findings and explore the reasons for gender differences.

We found some evidence of greater productivity losses with increasing levels of post-traumatic distress avoidance symptoms, consistent with findings from a small study of Canadian workers with chronic PTSD.[19] This requires further investigation among a larger sample. We did not find depression post-injury was associated with reduced productivity, possibly because PTSD and depression are often comorbid conditions.[16] In addition, those with more severe depressive symptoms may have had a delayed, or non-sustained RTW[41] and we were only able to include those who had made a RTW in our analysis. Phasing RTW with reduced working hours or amended duties can help patients make a successful RTW.[42] If participants with a phased RTW were not undertaking duties commensurate to those prior to their injury, our study may have underestimated productivity losses.

Implications for research and practice

Females, those with a history of psychiatric conditions in the 2 years prior to injury and those with higher levels of posttraumatic distress avoidance symptoms may need additional support to enable a successful RTW, particularly in terms of physical and time management demands. Health care professionals, employment advisors and employers should explore the impact of injuries on ability to perform pre-injury work tasks and seek early specialist support (e.g. occupational health services, vocational rehabilitation or other RTW services) where required. Engaging patients with such services, especially those with avoidant thoughts and behaviours may be challenging. Early identification and treatment of PTSD is likely to be beneficial.[43] The potential negative effects of productivity loss and the drivers influencing it also need addressing as part of the RTW planning process. Productivity losses of more than one week in the first-year post injury are a substantial loss for employers, the self-employed and society given the high rate of unintentional injuries in working age adults. Further research, with larger study populations is required to assess the impact of specific unintentional injuries (e.g. injury mechanism, body part injured and place of injury), occupation and employment status (e.g. employed, self-employed, full-time, part-time) as well as the role of gender, ethnic group and organisational factors on work limitations post-injury.

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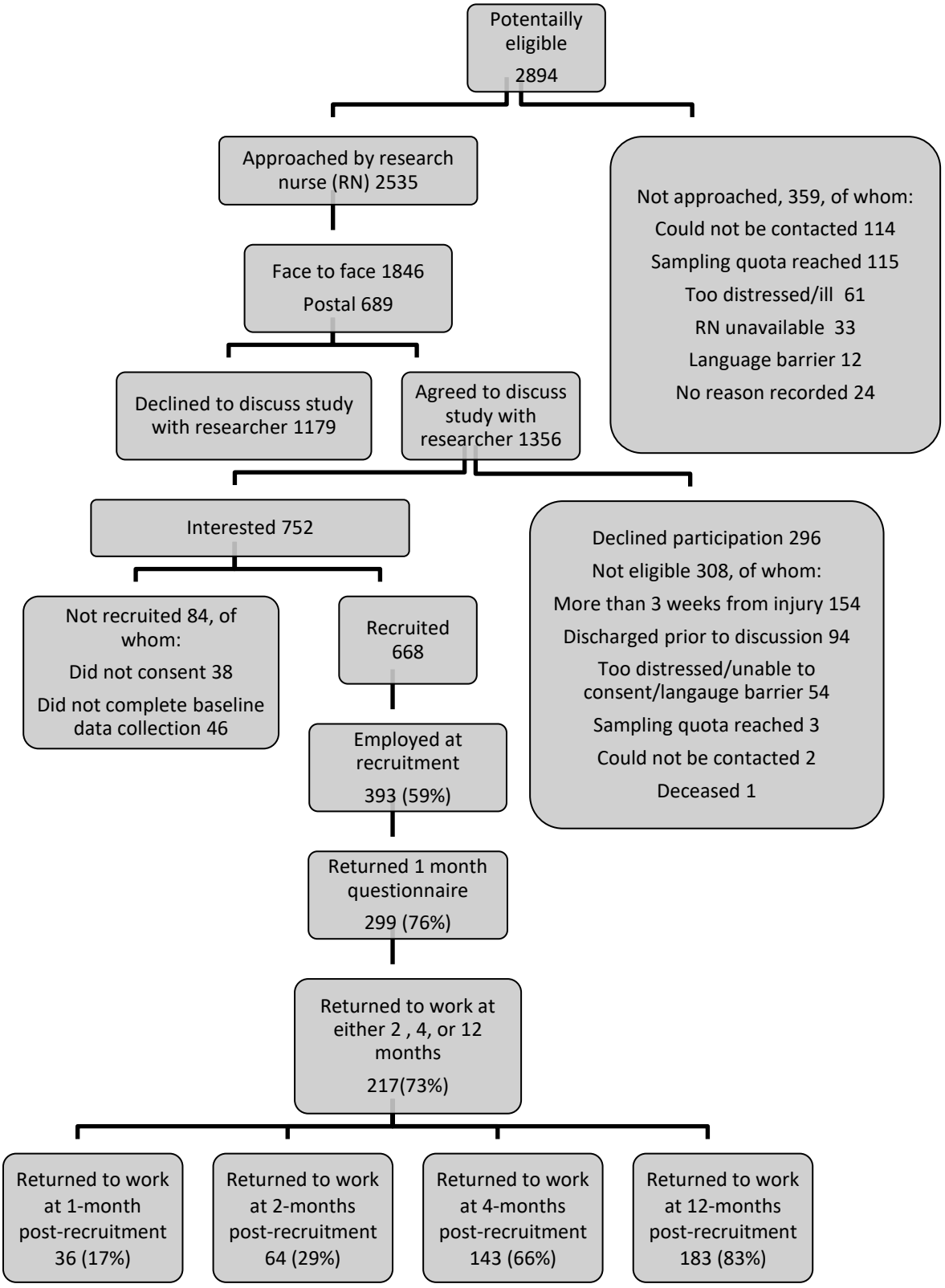

Fig 1 Flowchart of study participants, and those eligible for the analysis

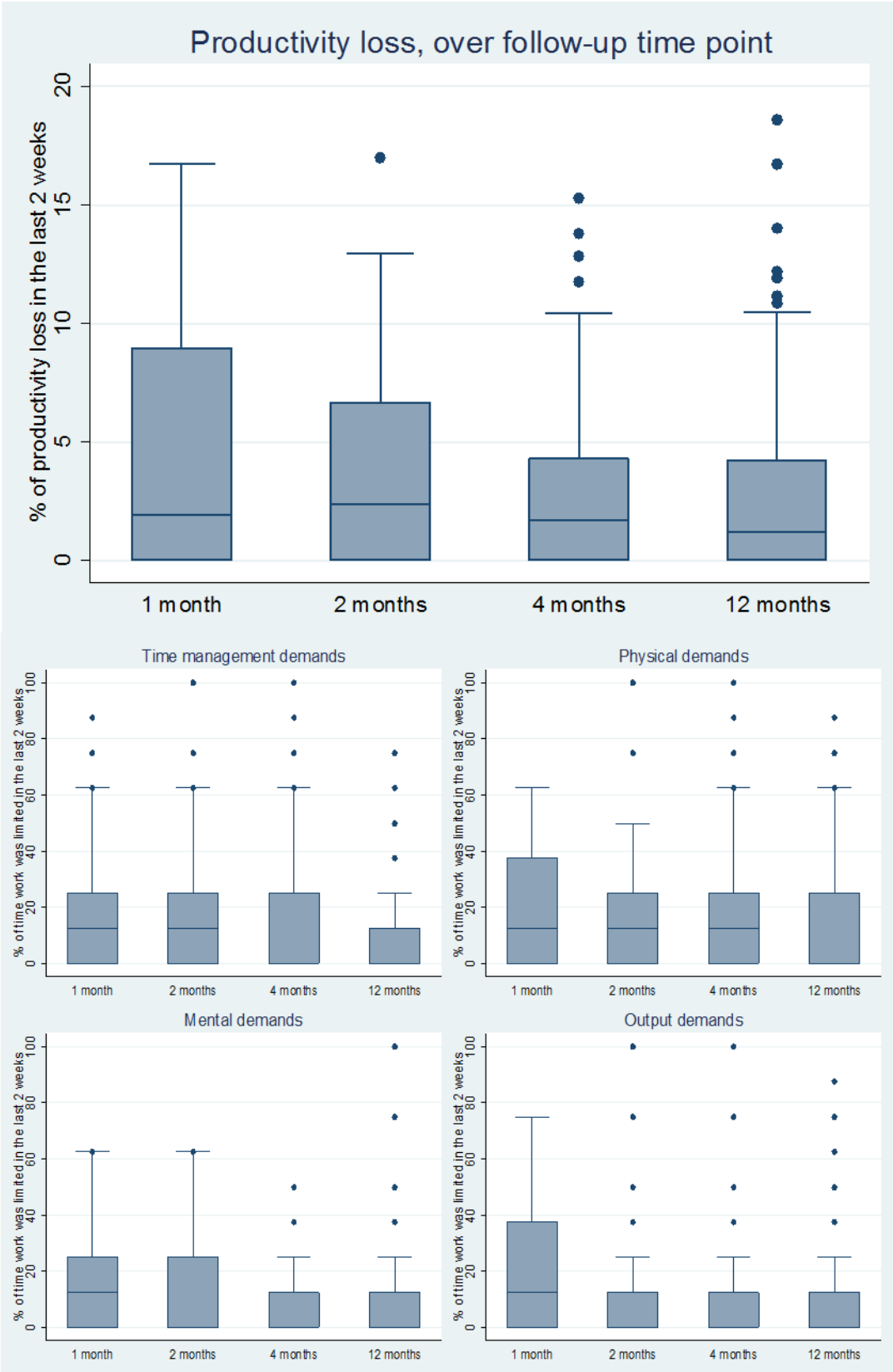

Fig 2 Box and whisker plots of productivity loss scores and constituent domains (time management demands, physical demands, mental demands, and output demands), over time

Online table 1 Adjusted odds ratios for baseline and one month post-recruitment predictors of higher productivity loss* in the multiple imputation analysis

Characteristics	Model A: A-priori confounders (n=240)	Model B: Model A + psychological predictors at 1 month (n=240)	Model C: Model B + psychological, socio-demographic, and injury characteristics at recruitment (n=239)**
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
A-priori confounders			
Centre			
Nottingham	1.00	1.00	1.00
Loughborough	0.96 (0.42, 2.22)	1.17 (0.50, 2.77)	1.57 (0.69, 3.57)
Bristol	1.03 (0.45, 2.37)	1.12 (0.49, 2.56)	1.01 (0.51, 2.35)
Surrey	0.48 (0.15, 1.51)	0.68 (0.18, 2.56)	0.91 (0.25, 3.31)
Age			
16-24	1.00	1.00	1.00
25-44	0.77 (0.26, 2.34)	1.17 (0.39, 3.46)	1.61 (0.55, 4.72)
45-64	1.28 (0.44, 3.75)	1.76 (0.60, 5.15)	1.78 (0.63, 4.99)
65+	0.71 (0.06, 8.22)	1.11 (0.10, 12.64)	1.53 (0.15, 15.81)
Sex			
Female	1.00	1.00	1.00
Male	0.38 (0.17, 0.87)	0.42 (0.19, 0.92)	0.39 (0.17, 0.90)
Time			
2 months	1.00	1.00	1.00
4 months	0.78 (0.32, 1.92)	0.78 (0.31, 1.99)	0.74 (0.29, 1.86)
12 months	0.69 (0.29, 1.63)	0.70 (0.29, 1.72)	0.63 (0.26, 1.54)
Mental health predictors at 1 month post-recruitment			
IES-A scale		1.09 (0.99, 1.21)	1.08 (0.99, 1.18)
Psychological, socio-demographic, and injury characteristics at recruitment			
Injured body part			
other			1.00
upper			0.62 (0.20, 1.95)
lower			1.04 (0.38, 2.88)
both			0.41 (0.09, 1.92)
Injury mechanism			
other			1.00
falls			0.75 (0.24, 2.34)
traffic			2.72 (0.60, 12.36)
struck			1.43 (0.34, 6.05)
Place of injury			
Home			1.00
Work			1.88 (0.62, 5.69)
Road			0.88 (0.27, 2.84)
Countryside			1.31 (0.45, 3.76)
Sports facilities			0.46 (0.13, 1.60)
Other			1.39 (0.52, 3.70)

Number of recent past psychiatric diagnoses (SCID)	
0	1.00
≥1	14.60 (3.02, 70.67)

*Higher productivity loss = above median of WLQ productivity loss scale. **Model C and D are the same model; no other predictors at 1 month were retained in the final model. IES-A=IES avoidance. SCID=structured clinical interview.

Online table 2. Adjusted odds ratios for baseline and 1-month post-recruitment predictors of higher productivity loss* in analysis of multiply imputed data

Characteristics	Model A: A-priori confounders (n=240)	Model B: Model A + psychological predictors at 1-month (n=240)	Model C: Model B + psychological, socio-demographic, and injury characteristics at recruitment (n=239)**
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
A-priori confounders			
Centre			
Nottingham	1.00	1.00	1.00
Loughborough	0.96 (0.42, 2.22)	1.17 (0.50, 2.77)	1.57 (0.69, 3.57)
Bristol	1.03 (0.45, 2.37)	1.12 (0.49, 2.56)	1.01 (0.51, 2.35)
Surrey	0.48 (0.15, 1.51)	0.68 (0.18, 2.56)	0.91 (0.25, 3.31)
Age			
16-24	1.00	1.00	1.00
25-44	0.77 (0.26, 2.34)	1.17 (0.39, 3.46)	1.61 (0.55, 4.72)
45-64	1.28 (0.44, 3.75)	1.76 (0.60, 5.15)	1.78 (0.63, 4.99)
65+	0.71 (0.06, 8.22)	1.11 (0.10, 12.64)	1.53 (0.15, 15.81)
Sex			
Female	1.00	1.00	1.00
Male	0.38 (0.17, 0.87)	0.42 (0.19, 0.92)	0.39 (0.17, 0.90)
Time			
2-months	1.00	1.00	1.00
4-months	0.78 (0.32, 1.92)	0.78 (0.31, 1.99)	0.74 (0.29, 1.86)
12-months	0.69 (0.29, 1.63)	0.70 (0.29, 1.72)	0.63 (0.26, 1.54)
Mental health predictors at 1-month post-recruitment			
IES-A scale		1.09 (0.99, 1.21)	1.08 (0.99, 1.18)
Psychological, socio-demographic, and injury characteristics at recruitment			
Injured body part			
other			1.00
upper			0.62 (0.20, 1.95)
lower			1.04 (0.38, 2.88)
both			0.41 (0.09, 1.92)
Injury mechanism			
other			1.00
falls			0.75 (0.24, 2.34)
traffic			2.72 (0.60, 12.36)
struck			1.43 (0.34, 6.05)
Place of injury			
Home			1.00
Work			1.88 (0.62, 5.69)
Road			0.88 (0.27, 2.84)
Countryside			1.31 (0.45, 3.76)
Sports facilities			0.46 (0.13, 1.60)
Other			1.39 (0.52, 3.70)

Number of pre-injury psychiatric conditions (SCID)	
0	1.00
≥1	14.60 (3.02, 70.67)

*Higher productivity loss = above median of WLQ productivity loss scale. **Model C and D are the same model; no other predictors at 1-month were retained in the final model. IES-A=IES avoidance. SCID=structured clinical interview.