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The effects of single and multiple concussions: Psychological well-being, individual experiences, and self-reported knowledge

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Concussion is a mild traumatic brain injury defined by a change in mental status resulting from mechanical trauma to the brain. Although most people recover from concussion, long-term physical and psychological effects are common. Our purpose was to (1) examine the impact and knowledge of symptoms and potential treatments and, (2) assess the impact of concussion on psychological well-being. Participants completed an online questionnaire to assess their concussion history, concussion knowledge, and psychological wellness. Overall, 96 participants indicated having one concussion, 109 reported multiple concussions, and 255 had no concussion history. Interestingly, there were few psychosocial differences between participants who reported one or multiple concussions. Concussion history was associated with lower life and leisure satisfaction and higher depression and loneliness. Perceptions of concussion symptoms, severity, and medical advice was inconsistent suggesting that education focused on long-term psychological consequences would be useful for laypersons and professionals.

KEY WORDS: concussion, mild traumatic brain Injury (mTBI), satisfaction with life (SWL), depression, loneliness.

Although most individuals who suffer from a concussion report a full recovery within six to 12 months, longer-lasting cognitive impairments can occur (Losoi et al., 2016). In best-case scenarios, prescriptions for physical and mental rest rely on symptom assessment and concussion history (McAbee, 2015). In addition to the immediate physical consequences of concussion, sports-related concussions have long-term psychiatric side effects (Emery et al., 2016; Mrazik et al., 2016; Yang et al., 2015), including depressive symptomology (Broshek et al., 2015; Finkbeiner et al., 2016). Individu-

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als reporting pre-concussion depressive symptoms are more likely to report heightened anxiety and depression post-concussion. Although they did not consider concussion number or time since last concussion, Chrisman and Richardson (2014) reported a link between history of concussion in adolescence and later depressive symptoms. Sustaining more than one concussion could increase risk for future psychiatric symptoms and these risks could change over time. These long term effects coupled with the fact that immediate physical and cognitive rest can decrease recovery time (Taubman et al., 2016) highlight the importance of research focused on determining the extent of the psychological impact of concussion beyond the acute recovery phase (Emery et. al, 2016). Given the impact of concussion on overall psychological and physical wellness, the goal of this research was to examine the effects of concussion on subjective well-being and explore general knowledge of symptoms, treatment, and impact of sustaining a single and multiple concussions.

In spite of increased information and education, players, parents, and coaches are not always aware of the consequences, treatment, and recovery suggestions for concussion. For example, in the United Kingdom, the consequences of concussion are underestimated and, in spite of increased confidence, individuals with a history of concussion often support erroneous information suggesting that their experiences contributed to an inflated perception of knowledge (Weber & Edwards, 2012). Further, in Canada, many Minor Hockey League players were not aware what a concussion was or of typical treatments and 25% did not know they should discontinue play if concussion symptoms occurred (Cusimano et al., 2009). The lack of knowledge extends beyond the children; parents, coaches, and teachers are also ill-informed on assessment, rest, and recovery protocols (Haran et al., 2016). To extenuate these problems, players are more likely to underreport symptoms, leading to misdiagnosis and a premature return to activities (Meier et al., 2015). The pressure to perform, coupled with the fact many young concussion sufferers are not assessed by medical professionals, can lead to an immediate return to play (Kroshus et al., 2015), which increases the risk of multiple, concurrent concussions that have longer lasting cognitive and physical impact.

Purpose of The Current Study

Understanding of the impact of concussion on everyday activities and well-being allows informed decisions about personal care. Thus, our purpose was to examine perceptions of concussion symptoms and recovery in a sam-

ple of young adults who may or may not have a history of concussion. Further, factors associated with life satisfaction were examined to determine the effect of concussion on psychological well-being. Our overall goal was to assess concussion knowledge and determine how concussion history impacts overall well-being, depressive symptoms, and loneliness. Thus, we focused on four research questions:

1. What is the long-term impact of single and multiple concussions on health?
    a. Do individuals who report multiple concussions face a larger detrimental impact?
    b. What physical and psychological symptoms are commonly reported by individuals who report a single and multiple concussions?
2. How does concussion (single vs. multiple) affect variables associated with psychological distress and well-being?
3. Are individuals aware of specific concussion symptoms and treatments?
    a. Are individuals who have a history of concussion more knowledgeable than individuals who did not report having a concussion?
4. What medical advice do individual who suffer a concussion report receiving?

Method

Participants

In total, 460 Canadians (89 males, M_{age} = 29.51 years; 360 females, M_{age} = 27.83 years) completed the questionnaire package. Ninety-six participants indicated having one concussion (20 males, 75 females), 109 reported multiple concussions (24 males, 81 females), and 255 reported no history of concussion (45 males, 204 females).

Materials

In addition to a demographics questionnaire that included questions about concussion history, knowledge, and medical advice, participants completed several psychosocial scales. We focused on dependent variables that included depression, fear or social isolation, loneliness, and leisure satisfaction. The Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) is a nine-item depression scale that measures the DSM-IV criteria for depressive disorder (Kroenke et al., 2014) and is valid for both diagnosis and to infer symptom severity. The Fear of Social Isolation Scale (FSI; Matthes et al., 2009) is a trait based inventory that includes five questions that measure social isolation (Hayes et al., 2009). The Social and Emotional Loneliness Scale for Adults – Short Form (SELSA-S; DiTommaso et al., 2004) is a 15-item questionnaire that includes three subscales measuring Social (4 questions), Romantic (6 questions), and Family (5 questions) Loneliness.

Participants also completed variables associated with well-being. The Satisfaction with

Life Scale (SWLS; Diener et al., 1985) includes five-items rated on a 7-point Likert-type scale rated from strongly agree to strongly disagree. The Leisure Satisfaction Scale (LS; Coyle et al., 1994) includes five items measured on a 5-point and is successfully used on diverse adult populations, including those with spinal cord injuries.

Procedure

The Research Ethics Board at the University of New Brunswick approved this study. Information about the study was posted on social media sites, including groups specific to individuals with a history of concussion and all data was collected using an online survey platform. Students from the University of New Brunswick received bonus marks for participation. After providing informed consent and answering demographic questions, participants indicatd whether they had sustained one, multiple, or no previous concussions, which determined which questionnaires would be presented. With the exception of the demographic questionnaire, which was always presented first, the measures were counterbalanced.

Data Analysis Strategy

Prior to conducting data analysis, the data were examined to identify outliers and missing values. We tested the assumptions underlying all statistical tests (i.e., normality, linearity). To assess the long term impact of concussion (Research Question 1) and symptom severity and number (Research Question 2), descriptive statistics for the overall sample and sub-groups of interest (no history of concussion, single concussion, and multiple concussion) were calculated and t-tests and analyses of variance (ANOVA) were used to assess specific differences. Pearson Product Moment Correlation Coefficients were used to assess the association between time since concussion and number and severity of symptoms. ANOVA was used to examine the impact of concussion (0, 1, >1) on psychosocial variables (Research Question 3). To determine specific effects of the dependent variables on life satisfaction, a hierarchical linear regression was conducted. To assess symptom knowledge and medical advice (Research Question 4), percentages were used to assess sub-group knowledge.

Results

Research Question 1: What is the long-term impact of single and multiple concussions on health?

The time since last concussion (M_{years} = 4.40, *SD* = 5.98) was variable, ranging from one day to 24 years. A wide range of symptoms and symptom severity were reported, with the number of symptoms experienced ranging from 1 to 28 (*M* = 19.17, *SD* = 8.25). Individuals who reported a single concussion reported significantly fewer symptoms (M = 15.35 vs. 20.29; $t = 3.94$, $p<.001$) and lower symptom severity (M = 3.38 vs. 5.05; $t = 4.31$, $p<.001$) than those who reported multiple concussions. Multiple concussion was associated with significantly higher headache, concentration problems, men-

tal fatigue, fatigue, distractibility, light sensitivity, irritability, and frustration tolerance severity (see Table I).

Research Question 2: How does concussion (single vs. multiple) affect variables associated with psychological distress and well-being?

Concussion history was associated with significantly lower satisfaction with life and leisure satisfaction scores as well as higher depression and loneliness scores (see Table II). Post hoc analyses revealed that a single or multiple concussion led to significantly lower satisfaction with life and leisure satisfaction as well as significantly higher depression and loneliness. Interestingly, with the exception of leisure satisfaction, individuals who

Table I
Number Of Symptoms And Mean Severity Of Symptoms Reported (N = 205).

Symptom	**Single Concussion**		**Multiple Concussions**		
	Symptom Reporting *n* (%)	Mean (SD) Range 1 – 10	Symptom Reporting *n* (%)	Mean (SD) Range 1 – 10	*t*
Headache	81 (84.4%)	6.81 (3.03)	103 (94.5%)	7.17 (2.37)	3.32**
Poor Concentration	79 (82.3%)	6.23 (3.01)	92 (84.4%)	7.79 (2.31)	3.77^***
Mental Fogginess	74 (77.1%)	5.91 (3.21)	94 (86.2%)	7.14 (2.86)	2.63**
Fatigue	70 (72.9%)	6.66 (3.05)	99 (90.8%)	8.03 (2.20)	3.23^**
Dizziness	68 (70.8%)	5.85 (2.74)	94 (86.2%)	6.70 (2.72)	1.95
Balance	68 (70.8%)	6.00 (3.14)	86 (78.9%)	6.37 (2.86)	0.77^
Distractibility	64 (66.7%)	5.55 (3.09)	88 (80.7%)	6.86 (3.04)	2.62**
Slowed Response Speed	56 (58.3%)	5.18 (2.98)	88 (80.7%)	5.95 (2.71)	1.61
Memory Difficulty	55 (57.3%)	5.56 (3.12)	88 (80.7%)	6.81 (2.52)	0.49^
Noise Sensitivity	56 (58.3%)	6.80 (3.13)	87 (79.8%)	7.66 (2.52)	1.79
Nausea	55 (57.3%)	5.65 (3.22)	80 (73.4%)	6.21 (2.92)	1.05
Light Sensitivity	54 (56.3%)	5.56 (3.16)	87 (79.8%)	8.00 (2.38)	2.89^**
Sleep Problems	53 (55.2%)	6.30 (3.15)	86 (78.9%)	7.20 (2.71)	1.78
Irritability	51 (53.1%)	6.08 (2.76)	82 (75.2%)	7.06 (2.78)	2.00*
Trouble Learning	52 (52.2%)	6.02 (3.22)	82 (75.2%)	6.80 (2.56)	1.47^
Problem Solving	49 (51%)	6.27 (2.98)	82 (75.2%)	6.55 (2.61)	0.57
Anxiety	49 (51%)	7.10 (2.71)	74 (67.9%)	7.00 (2.84)	-0.20
Vision Changes	48 (50.5%)	6.02 (3.35)	73 (67.0%)	6.88 (2.79)	1.47
Increased Emotionality	48 (50.0%)	6.65 (2.92)	81 (74.3%)	7.26 (2.68)	1.19
Tinnitus	46 (47.9%)	5.21 (3.35)	61 (56.0%)	6.13 (2.95)	1.50
Low Frustration Tolerance	45 (46.9%)	6.44 (2.86)	73 (67.0%)	7.71 (2.23)	2.54^*
Depression	44 (45.8%)	6.25 (3.33)	72 (66.1%)	6.67 (2.98)	0.70
Disorganization	43 (44.8%)	5.63 (2.73)	70 (64.2%)	6.19 (2.77)	1.05
Personality Changes	37 (38.5%	6.49 (2.47)	67 (61.5%)	6.66 (2.84)	0.31
Vertigo	36 (37.6%)	5.58 (3.35)	58 (53.2%)	6.38 (2.80)	1.24
Apathy	33 (34.4%)	5.30 (2.98)	56 (51.4%)	5.93 (2.90)	0.98
Panic Attacks	30 (31.3%)	5.07 (3.19)	57 (52.3%)	5.75 (4.12)	0.80
Sensitivity to Alcohol	30 (31.3%)	6.67 (3.43)	52 (47.7%)	7.13 (2.65)	0.65

*Note. *p<.05; **p<.01; p<.001;* ^ unequal variances corrected

Table II
Mean (SD) Of Variables Measuring Psychological Well-Being And Distress.

	0 Concussion	1 Concussion	>1 Concussion	F (p)	Post Hoc Comparison
Overall Satisfaction with Life	20.11 (SD = 4.49)	17.57 (SD = 6.56)	15.91 (SD = 6.73)	23.58 (<.001)	0 vs. 1 *p <.001* 0 vs. 2 *p<.001* 1 vs. 2 *ns*
Leisure Satisfaction	17.36 (SD = 3.86)	16.55 (SD = 5.28)	14.98 (SD = 5.22)	10.10 (<.001)	0 vs. 1 *ns* 0 vs. 2 *p<.001* 1 vs. 2 *.002*
Fear of Isolation	17.31 (SD = 4.02)	16.82 (SD = 4.45)	17.07 (SD = 4.93)	.47 (.623)	
Loneliness	2.67 (SD =1.21)	2.92 (SD = 1.07)	3.08 (SD = 1.17)	6.20 (.002)	0 vs. 1 *p =.04* 0 vs. 2 *p=.001* 1 vs. 2 *ns*
Depression	7.71 (SD = 5.96)	9.60 (SD = 7.20)	10.71 (SD = 7.01)	8.54 (<.001)	0 vs. 1 *p <.03* 0 vs. 2 *p<.001* 1 vs. 2 *ns*

reported single and multiple concussions reported similar levels of depression, loneliness, and satisfaction with life.

There were statistically significant correlations between the total number of symptoms and current depression ($r = .418$, $p < .001$), satisfaction with life ($r = -.480$, $p < .001$), and leisure satisfaction ($r = -.388$, $p < .001$) scores. Similar relationships were found with the reported severity of symptoms and the same variables (depression; $r = .470$, $p < .001$; satisfaction with life; $r = .525$, $p < .001$; leisure satisfaction, $r = .472$, $p < .001$). Time since their first reported concussion was not significantly correlated with depression, but was correlated with life ($r = .143$, $p < .04$), and leisure ($r = .143$, $p < .05$) satisfaction.

A hierarchical linear regression was conducted to predict SWL in those who reported previously sustaining a concussion. Gender, symptom severity, time since concussion (< 2 years, >2 years), and multiple concussion status (Y/N) were added in Block 1 and depression, total loneliness, fear of social isolation, and leisure satisfaction were entered in Block 2. Block 1 was statistically significant, $F(5, 181) = 14.61$, $p<.001$, and accounted for 27.3% of the variability. In this block, greater symptom severity, $\beta = -.48$. $t = -6.23$; $p < .001$, was associated with lower satisfaction with life. Block 2 was also statistically significant, $F(4, 172) = 38.94$, $p<.001$, $R^2 = .34$, with higher Leisure Satisfaction, $\beta = .49$; $t = 7.58$, $p = .001$, and lower Total Loneliness, $\beta = -.16$; $t = -2.79$, $p = .006$, contributing to life satisfaction. Interestingly, time since

injury and multiple concussion status were not statistically significant predictors of life satisfaction.

Research Question 3: Are individuals aware of specific concussion symptoms and treatments?

Although most respondents (70.4%; $n = 324$) agreed that a concussion is always a brain injury, 26.5% ($n = 122$) thought it was only sometimes a brain injury. Further, 17.5% of participants who had sustained multiple concussions reported that a concussion was not always a brain injury. Although most participants were aware that concussion was associated with headache, fatigue, and mental confusion, those with no concussion history were less knowledgeable about potential psychological consequences, such as depression and irritability (see Figure 1). Most participants who reported having multiple concussions reported they would go to a doctor (86.2%) if they sustained a concussion but 52% reported that they did not receive medical attention for all

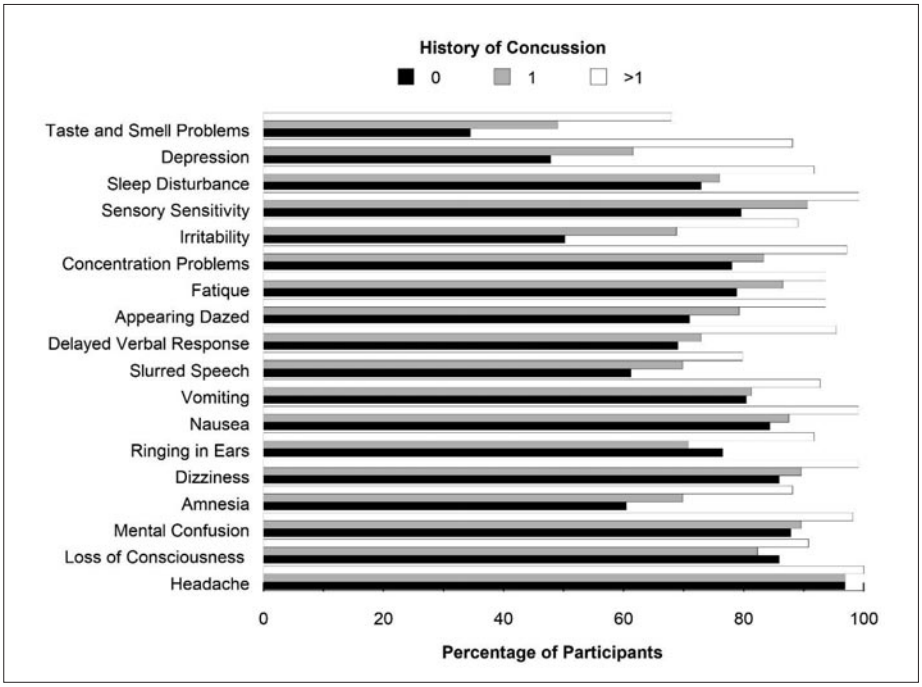

Fig. 1. - *Percentage of participants who associated specific symptoms with concussion.*

of their past concussions. Forty-eight percent thought they were at the same risk for concussion regardless of their prior concussion history; there were no perceived risk differences in people who reported no, single, or multiple concussions. Surprisingly, less than half of the sample was aware that physical (44%) and mental (43%) rest could shorten recovery time.

Research Question 4: What medical advice do individual who suffer a concussion report receiving?

Fifty-three percent of concussion sufferers who sought medical advice visited an emergency department. Although reported advice was inconsistent, common medical advice included: change their work/ school schedule (44%); avoid mentally (47.9%) or physically (70.2%) demanding tasks; sleep at night and take it easy during the day (61.5%); avoid alcohol and drugs (44%) and non-prescribed medicines (20%); drive a car, ride a bike or operating machinery (47.9%); and use pain medication as needed (52.1%). Medical advice was similar regardless of concussion history. Most participants (92.2%) who had a prior concussion lost time at work or school as a consequence of their injury; many filled their lost time with sedentary activities (Television, Sleeping, Rest).

Discussion

Research Question 1: What is the long-term impact of single and multiple concussions on health?

The current results included a sample of individuals who had sustained at least one concussion. Although participants reported a wide range of symptoms, generally individuals who suffered multiple concussions reported more symptoms and greater symptom severity. These results replicate Oyegbile et al. (2018), who studied post-concussion symptoms in a sample of individuals aged 10 to 20 years. Oyegbile et al. found that individuals who suffered multiple concussions had significantly more problems with cognitive function than those who reported a single concussion. Given that the risk factors for concussion are diverse (Lasry et. al., 2017) and may differ for pediatric and adult populations (Oyegbile et al., 2018), our results indicate the need for widespread educational programs that clearly outline treatment and return to activity guidelines.

Research Question 2: How does concussion (single vs. multiple) affect variables associated with psychological distress and well-being?

Consistent with Proctor and Best (2019), a history of concussion was associated with lower life and leisure satisfaction and higher depression and

loneliness. Previous research in ABI survivors has consistently found stable and lower life satisfaction across time (Forslund et al., 2013; Proctor & Best, 2019). In this sample, the average time since last injury was almost 5 years, suggesting these psychological outcomes are both significant and long lasting. These results coupled with the fact that the most robust predictor of life satisfaction among ABI survivors was leisure satisfaction (Proctor & Best, 2019) highlight that factors associated with subjective well-being are important, even in individuals who sustain less severe injuries. In spite of the links between leisure satisfaction and subjective well-being, the association between lowered leisure satisfaction and a previous concussion existed regardless of previous sports participation. We would argue that both a return to normal activities and productive leisure demands attention.

The interaction between depression history and brain injury is complex (Finkbeiner et al., 2016). Depression history is associated with a higher post-injury depression and anxiety risk, creating a vicious cycle for those suffering from pre-existing depression. Practitioners should be aware that indicators of post-concussion syndrome are not unique to concussion and of the commonalities between post-concussion syndrome and depression. Lange and colleagues (2011) reported that individuals with comorbid depression and mild TBI suffered more than those who did not suffer from depression. Elevated post-concussion severity scores may not be caused solely by long-term neurological damage but partially due to psychological symptomology. Further, some post-concussion symptoms may not be attributable to neurological deficits, but a reactive form of depression that causes physical reactions to injury-related stress (Moldover et al., 2004).

Research Question 3: Are individuals aware of specific concussion symptoms and treatments?

The current results suggest that the awareness of concussion symptoms and recommended treatment vary widely and suggest that inconsistencies in knowledge about post-concussion care were not dependent upon concussion history. Thus, our results replicate research suggesting that general symptom knowledge and the importance of post-concussion rest is lacking (Haran et al., 2016; Weber & Edwards, 2012), even among individuals who participate in higher risk activities (Cusimano et al., 2009). Our results highlight the need for education programs that focus on the importance of symptom recognition and highlight the importance of post-concussion treatment. Further, given that young female athletes are more knowledgeable about concussion symptoms (Wallace et al., 2017), coaches and parents should ensure that male athletes are aware of the impact of concussion and encouraged to report symptoms.

Research Question 4: What medical advice do individual who suffer a concussion report receiving?

The reported variations in medical advice suggest that patients either receive mixed advice from healthcare professionals or do not fully understand the advice provided. Given that the assessment of concussion can be complex and indices of concussion can focus on different long and short term symptoms (Dessy et al., 2017), the wide variety of advice reported in the current study is not surprising. The fact that individuals who reported multiple concussions were less likely to seek medical attention after their first concussion is also concerning. To further compound the problem, the misunderstanding of single and multiple concussion symptoms and treatments can result in a false sense of security that leads to individuals not seeking appropriate medical advice and, in some cases, fail to report concussion to coaches (Wallace et al., 2017).

Limitations and Directions for Future Research

Although the current study provides preliminary information about psychological correlates of concussion, it does have limitations. The snowball recruitment method led to a large number of participants but also a high dropout rate (~30%). Given the randomization of the measures, the incomplete responses were distributed across measures and no measure was devoid of responses. Further, given that concussion symptoms, timeline for care, and specific medical advice were self-reported, all limitations associated with self-report data applies. Additionally, we sampled widely and included participants with a variable concussion history (time since injury, number of concussions). Thus, our ability to pinpoint a time during recovery where symptoms changed was limited.

Despite these limitations, the current results highlight long-term psychological consequences of concussion and indicated that even a single concussion was associated with lower life and leisure satisfaction as well as higher depression and loneliness. Future research should focus on these longer term impact of concussion and longitudinal designs could focus on identifying factors associated with negative psychological consequences. Finally, given that individuals with single and multiple had similar (and lower) life satisfaction than individuals who did not have a history of concussion, research investigating the impact of even a single concussion is important.

Further, our results highlight the importance of education for individuals who sustain a concussion, caregivers, and coaches. There is a need for formal development and evaluation of education programs that highlight the importance of reporting injury, even when initial symptoms are not severe. Given that

concussion is associated with many short and long term symptoms and diagnosis can be complex, educational materials should focus on the importance of adequate rather than on specific symptoms (i.e., headache loss of consciousness).

Conclusions

Given the wide range of research on concussion (Emery et. al, 2016;), Finkbeiner, et al., 2016; Haran, et al., 2016; Kroshus, et al., 2015; Meier, et al., 2015), knowledge of the consequences of one concussion and the increased risk of sustaining multiple concussions should be commonplace. Current results indicate that further education is necessary both for those who are at a high risk for concussion and for medical professionals who are likely the first line of contact after injury. Although people have some general knowledge about concussions, their specific knowledge is often inconsistent and incorrect. Proper dissemination of relevant research results to the general public and medical professionals about the interactions and associations between concussions and psychological factors should be prioritized.

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