Chapter 5 – RISKY DRIVING BEHAVIOUR

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ABSTRACT

Road Traffic Accidents (RTAs) are leading causes of death and serious injury in military organizations, both in garrison and on operations. A broad range of risky driving behaviours contribute to RTAs, so preventing or changing these offers promise for accident prevention. Research from the Vietnam War and the 1990 – 1991 Persian Gulf War has shown a consistently higher risk of post-deployment RTA death in those who deployed in support of these conflicts relative to their non-deployed peers, particularly in the first years after return. Analysis of these RTA deaths implicates a broad range of disproportionate risky driving behaviours, such as drinking and driving and speeding. Cross-sectional surveys of driving behaviours also show an association between previous deployment and risky driving. A number of factors could plausibly contribute to this link, including methodological issues, drug and alcohol use, failure to adapt combat driving behaviours to the home environment, distress and mental disorders, suicidal intent, sleep disturbance, neurocognitive deficits due to traumatic brain injuries or toxic exposures, and changes in risk psychology variables related to deployment experiences. None of these factors have been convincingly confirmed or refuted through research, though substantial mediation by traumatic brain injury, neurotoxicity, or suicidal behaviour masquerading as an RTA is unlikely. In contrast, post-deployment distress and mental disorders could serve as a single, unifying explanation for all of the other plausible mechanisms. Development of specific interventions to mitigate post-deployment risky driving hinges upon a deeper understanding of which of these factors mediate the deployment-increased related risk.

5.1 PUBLIC HEALTH SIGNIFICANCE OF ROAD TRAFFIC ACCIDENTS IN MILITARY ORGANIZATIONS

Road Traffic Accidents (RTAs) are leading causes of death in military populations, even in times of war [1]-[5]. They are also common causes of death or serious injury on deployments, be they combat deployments [3];[6] or peacekeeping deployments [7]. RTAs also contribute heavily to serious injuries [8], with their attendant consequences in terms of health care costs, loss of productivity, and impaired well-being. One person's driving behaviour can obviously result in death or serious injuries to others (passengers, pedestrians, other drivers, etc.), triggering a special duty on the part of military organizations to attenuate any occupationally-related increased risks in RTAs. In addition, many military personnel drive as part of their military work, both on deployment and in garrison. Work-related RTAs can put other military personnel or non-combatants at risk, and expensive or scarce equipment can be damaged in on-duty RTAs [9]. For all of these reasons, military organizations take an active interest in preventing RTA in military personnel.

5.2 RISKY DRIVING BEHAVIOURS

A broad range of driver behaviours contribute to RTAs or to injury severity resulting from them [10]-[12]:

- Alcohol and drug use;
- Speeding;
- Frequent or rapid lane changes;
- Failing to signal;

- Tailgating;
- Motorcycle use;
- Failing to use a helmet on a motorcycle;
- Failing to wear a seatbelt;
- Driving while drowsy; and
- Engaging in distracting behaviour (e.g., cell phone use) [13];[14].

Many of these risk factors have also been confirmed in military populations [9];[15].

5.3 ENVIRONMENTAL FACTORS THAT CONTRIBUTE TO ROAD TRAFFIC ACCIDENTS

Environmental factors also contribute to RTAs [12]: Road design and maintenance, vehicle characteristics, weather and climate, regulation, law enforcement practices, macroeconomics, etc., can all influence whether people drive at all, how much they drive, where the drive, when they drive, and of course *how* they drive. That is, the physical/social environment directly contributes to RTAs, and it also can interact with driver behaviour to influence RTAs and related deaths/injuries [12].

5.4 THE EFFECT OF MILITARY DEPLOYMENTS ON RISKY DRIVING BEHAVIOURS

5.4.1 Different Approaches to Studying the Effects of Military Deployments on Risky Driving

The influence of deployment on RTAs has been explored using both health surveillance statistics (for both fatal and non-fatal accidents) and driver behaviour surveys.

5.4.1.1 Health Surveillance Studies

Accident surveillance data can provide compelling evidence of ultimate outcome of interest, and it can document the absolute public health impact of deployment-related changes in RTA patterns. Accident surveillance statistics may also provide insight into some driver behaviours (e.g., speeding, seatbelt use, fatigue, alcohol and drug use) but it can’t provide any sense of how habitual these behaviours are. Unfortunately, the cause of death recorded on death certificates grossly underestimates the contribution of alcohol to RTA deaths [16].

5.4.1.2 Survey Studies

Surveys are most useful when it can be established that particular driver behaviours are causally linked with the risk of serious RTAs. The complementary value of the survey approach is several-fold: First, risky driving behaviours are far more prevalent than serious accidents, resulting in greater statistical power. Collecting survey data is feasible before and after deployment, removing many important sources of bias. Surveys also permit the testing of certain causal hypotheses, particularly those that relate to the psychological processes that underlie risky driving behaviour. This level of detail is seldom available in surveillance studies. Finally, survey data can provide early evidence that interventions designed to limit the risk of RTAs are working.

5.4.2 Civilian-Military Comparisons

Civil-military comparisons could be used to explore the possible associations between military service and either accident rates or driving behaviours reported on surveys; such comparisons have been used to explore the potential link between military service and suicide [17] and mental health problems [18];[19]. These sorts of comparisons require careful adjustment for potential confounding factors: Many factors other than deployment-related changes in driving behaviour that might explain any observed differences. It is plausible, for example, that the risk taking propensity of individuals who choose to serve in the military is different from that in the general population [20], and accident surveillance data never capture this dimension well enough to permit the necessary adjustments. In any case, only a single mortality surveillance study exploring this issue could be identified [21]; this study showed that US Vietnam veterans had a slightly higher risk of fatal RTA than their general population counterparts of the same age and sex during the first five years after return from deployment (but not thereafter).

5.4.3 Studies on the Association of Deployment with Road Traffic Accidents

A number of studies have convincingly demonstrated that previously-deployed service members have a significantly elevated risk of fatal RTAs compared to their non-deployed military peers. The two conflicts that have been studied the most are the Vietnam War [21]-[25] and the 1990 – 1991 Persian Gulf War [26]-[33]. The excess risk is small in absolute terms (e.g., risk ratios of ~1.3 [34], but because RTAs are a leading contributor to death, even a small risk ratio has important public health implications. The risk of some other external causes of death (e.g., poisoning, homicide, suicide) have also been shown to be elevated in Vietnam veterans [21];[25] and those who deployed in the 1990 – 1991 Persian Gulf War [26];[27];[34]. The increased risk of fatal RTA appears to wane over time [21];[27];[34]. In the Gulf War at least, those in combat occupations had higher rates of RTA death than other military occupations [29].

Data from the Second World War era and the Korean War era have also shown an excess in external causes of death, but only in those who actually deployed to the theatre of operations (cited in [25]).

Exploration of the details of RTA deaths in previously deployed vs. non-deployed cohorts has pointed to a number of differences in the accident circumstances [35]. The deployed cohort had an excess of RTA deaths involving:

- Failure to wear seat belts;
- Failure to use motorcycle helmets;
- Failure to engage in crash avoidance manoeuvres;
- Speeding;
- Alcohol use;
- Single vehicle accidents;
- Collisions with a fixed object;
- Rollovers;
- Ejections from the vehicle;
- Drivers with previous alcohol-related driving infractions; and
- Death within one hour of the accident.

The US military has used surveillance data [36] to explore the temporal relationship of RTA fatalities relative to the deployment cycle. There were 1.5 times as many deaths in the first 30 days after return from

a deployment than at other periods of service. However, this period accounted for only a small minority (3%) of all RTA deaths.

There is also data that the increased propensity to injury after deployments goes beyond RTAs: Gulf War Veterans report more injuries in general on post-war surveys [37], and they appear to be hospitalized more often for physical trauma than their non-deployed peers [38];[39].

5.4.4 Prevalence of Self-Reported Risky Driving Behaviour in Military Organizations

This section summarizes the prevalence of self-reported risky driving behaviours in military personnel.

5.4.4.1 Driving and Alcohol Use

Survey data from the US showed that an important minority of active duty military personnel reported driving after having had too much to drink in the previous 12 months (9% in the Army, 11% in the Navy, 11%, in the Marine Corps, and 7% in the Air Force) [40]. Among heavily combat-exposed US Army personnel surveyed very shortly after their return, 7% reported having driven after having several drinks or having ridden with a driver who had had too much to drink *over the previous 4 weeks.* Recent survey data from Canada [41] showed that 5.5% of Regular Force personnel had driven after having had too much to drink in the previous 12 months; 6.1% reported having been a passenger in a vehicle in which the driver had had too much to drink; these rates appear to be lower than the corresponding civilian population in Canada [41].

5.4.4.2 Seat-Belt and Helmet Use

Data on seatbelt use are more encouraging: 94% of US military personnel reported using seatbelts “always” or “often” [40]; similar rates have been reported in the UK military as part of a cohort study [42]. Of US military personnel who had operated a motorcycle in the previous 12 months, 87% reported using a helmet “always” or “nearly always” [40]. In a UK post-deployment sample, 88% reported using seatbelts “always” or “nearly always” when riding in the front seat [42]. Rear-seat use was less consistent (69%) [43]. Unfortunately, self-reported seatbelt use is known to overestimate actual use relative to studies that involve actual behavioural observation [44].

5.4.4.3 Other Risky Driving Behaviours

Fear et al. [42] reported that 14% of their UK military cohort usually drove more than 20 miles per hour (32 km/hr) over the speed limit on the motorway; Verrall’s [43] post-deployment sample reported this behaviour at similar rates (15%). Verrall [43] also found that 7% reported usually driving more than 10 miles per hour (16 km/hr) over the speed limit in built-up areas. Driving while sleepy is an important risk factor for accidents [45], but published prevalence rates in military populations are limited: Radun [46] found that more than half of Finnish military conscripts reported driving while fatigued in the previous two months and that falling asleep at the wheel was the leading cause of fatal accidents in this population.

5.4.5 Studies on the Association of Deployment and Combat Experiences with Driver Behaviour Reported on Surveys

Only a limited number of studies have explicitly explored the association between previous deployment and risky driving behaviours. In all cases, at least some positive association was found. Fear et al. [42] in the UK found that deployment in the very earliest phase of the Iraq war was an independent risk factor for risky driving, with an adjusted odds ratio of 1.3. Deployment a bit later in the conflict (when the threat level was lower) was not independently associated with risky driving. In the Canadian Forces, deployment

over the previous two years had a very small, univariate association with a health and safety scale that included items on risky driving [47]. This was, however, prior to the CF's widespread involvement in combat operations in Kandahar province. A population-based military survey in the US [48] found that an aggregate outcome of a number of high risk *drinking* behaviours (drinking and driving among them) had a modest, univariate association with lifetime combat exposure.

Killgore et al. [20] studied US Army personnel approximately 3 months after a demanding combat deployment in Iraq. While there was no non-deployed control group, they did show that higher levels of combat exposure had a small, independent association with a scale measuring risk-taking propensity; the scale included risky driving as well as other risky behaviours. However, only specific types of combat exposures had this association, and the association varied somewhat by the type of risk-taking behaviour. The types of combat exposure most consistently associated with risky behaviour were exposure to violent combat, having killed combatants, and having killed "friendlies" or non-combatants.

Longitudinal data on driving behaviour across the deployment cycle is limited to a single study by Verrall [43] on a single UK mechanized brigade deployed to Iraq in 2008. Somewhat surprisingly, seat-belt use and speeding was reported *less* frequently in the post-deployment period relative to the pre-deployment period.

5.5 SUMMARY OF RISKY DRIVING BEHAVIOURS IN THE MILITARY

A broad range of risky driving behaviours are seen in an important minority of military personnel. Risky driving behaviours contribute to RTAs, which in turn represent a heavy burden in terms of serious injuries and mortality. Survey data largely points to an association between combat deployments and risky driving behaviour. The magnitude of this effect is small, and in fact may be undetectable in those with little or no combat exposure. Moreover, there is consistent evidence that this behaviour (and perhaps other unmeasured factors) express themselves in the consistently higher rate of motor vehicle accidents (and other external causes of death) seen at least in the first years after return from at least some deployments (notably the Vietnam War and the 1990 – 1991 Gulf War). In epidemiological terms, the magnitude of this increased mortality risk is small [34], but its public health impact is large in military populations due to the large fraction of all deaths that are due to RTAs [1]-[5].

5.6 POSSIBLE EXPLANATIONS FOR THE ASSOCIATION OF RISKY DRIVING BEHAVIOURS AND MILITARY DEPLOYMENTS

A number of different hypotheses have been proposed to explain the association between deployment and risky driving behaviours/RTA death.

5.6.1 Selection Bias

It is plausible that those who choose to enter military service may **possess** factors (such as lower risk aversion) that may predispose **them** to accidental death. This **hypothesis could be rejected** because most of the modern research compares deployed veterans against their non-deployed peers (e.g., [25];[30];[39].

It is harder to reject out of hand the hypothesis that service members *selected for deployment* might differ in important ways from those who happen not to deploy. Clearly, selection for deployment is not a random event in modern military organizations – important differences in health status between deployers and non-deployers have been demonstrated, even after substantial adjustment for potential confounding factor [49]-[51]; this has been termed the "healthy warrior effect". In addition to being healthier, it is possible that deployers exhibit other, unmeasured individual differences that are associated with risk taking propensity.

5.6.2 Drug and Alcohol Use

As noted elsewhere in this report, deployment has been clearly associated with an increased risk of both hazardous drinking and overt alcohol use disorders. To the extent that these are associated with a substantially increased risk of RTA (particularly *fatal* RTA) [12], it is plausible that alcohol use could mediate the link between deployment and RTA. Indeed, it would be surprising if the clearly increased alcohol use after deployment did *not* translate into a higher risk of RTA, given the strong association between heavy drinking and RTA deaths. As noted earlier, survey data has shown that UK service members who had deployed to Iraq more often reported having driven under the influence than their non-deployed peers [42].

The excess of RTA deaths in the early post-deployment period [36] mirrors the higher rates of risky drinking seen over the same period [40]. Detailed evaluation of the circumstances of accidents of Gulf War Veterans offers support to this hypothesis: Fatal crashes with GWVs were somewhat more likely to have involved alcohol than those involving their non-deployed peers [35];[52]. They were also more likely to have had a previous conviction for driving under the influence [35];[52].

Illicit drug use has also been reported as a consequence of military deployments, particularly in Vietnam veterans [53]. Marijuana use is prevalent among men of military age and has been shown to be inconsistently associated with RTAs [54];[55]; the negative effects of marijuana and alcohol appear to be synergistic [54].

In other words, there is a range of evidence that suggests that at alcohol use is at least a partial mediator of the link between combat deployments and RTA fatalities. A connection with illicit drug use is also plausible, but data are sparse. No studies directly addressed whether the observed increase in RTA is *fully* accounted for by hazardous drinking or alcohol use disorders.

5.6.3 Failure to Adapt Combat Driving Habits to the Home Environment

Driving in today's combat environment in Southwest Asia results in a variety of potentially adaptive changes in driving behaviour [56] that are intended to minimize the risk of improvised explosive devices, which are of course the weapon of choice of the insurgents. These adaptations include speeding, straddling the centre line, making unpredictable turns or lane changes, running red lights, etc. In fact, soldiers receive combat driving training to prepare them for these challenges.

Even in theatre, these driving behaviours must offer both risks and benefits, but once home, these "adaptations" are no longer so adaptive: They only present a significantly increased risk of RTA. For this reason, the US Army offers mental health training at the time of re-deployment [57] that is intended to sensitize personnel to the need to change these behaviours once they are home.

There is abundant anecdotal evidence that these combat driving behaviours do persist in at least some personnel [58]. In a survey of National Guard personnel who had returned form a combat deployment, Stern et al. [58] found that in the preceding 30 days, 25% had straddled the centre line or driven into oncoming traffic, 25% had run a stop sign, and 10% had driven erratically in a tunnel or on an overpass. Part of this persistence of combat driving must be simply an ingrained habit; many driving behaviours have a reflexive/habitual element. If so, it is somewhat surprising that personnel who drove in theatre are about as likely to report the persistence of these behaviours as those who didn't drive [58].

In a clinical sample of veterans of a number of conflicts who were in residential treatment for PTSD, Kuhn et al. [59] showed that lifetime aggressive and unsafe driving behaviours were highly prevalent. Interestingly, veterans of the current conflicts in Southwest Asia reported these at higher rates than veterans of previous conflicts, raising the possibility that the unique driving-related hazards of the current conflicts may be a contributing factor to these behaviours. If that is true, then other explanations will need

to be invoked to explain the elevated risk of RTA deaths in veterans of other conflicts. In other words, failure to adapt the unique combat driving behaviours used in the current conflicts cannot be the *only* explanation for deployment-related risky driving behaviour and excess RTA mortality.

An alternative explanation for the persistence of combat behaviours is post-combat anxiety, which is discussed below.

5.6.4 Anxiety and Depression

Anxiety is a common post-deployment symptom, particularly after combat deployments [60]. This can take the form of PTSD, other anxiety disorders, an adjustment disorder, a sub-threshold condition, a symptom of another disorder (e.g., depression), or simply a normal reaction to the challenges of reintegration after a difficult deployment. High levels of anxiety can degrade driving performance through anxiety-related performance deficits (e.g., having trouble finding the right lane), exaggerated safety behaviours (e.g., repeatedly looking at in the rear-view mirror), and anxiety-related anger/aggressivity (e.g., tailgating a driver that triggered anxiety) [61]. In theatre, anxieties about seatbelt use lead to widespread non-compliance with the official requirement to wear seatbelts at all times; personnel are concerned about being able to exit the vehicle or access their weapon in case of an emergency [62]. This may a military example of exaggerated safety behaviour.

In qualitative work with US National Guard personnel after a demanding combat deployment, Stern et al. [58] found that persistent, irrational driving-related anxieties were common. That is, personnel had feelings of anxiety related to non-existent threats such as IEDs. Survey research showed that these anxieties were strongly associated with risky combat driving behaviour in the post-deployment period. Risky driving behaviour declined over the post-deployment period, though the anxieties persisted. Other anxiety-related driving deficits are possible, too. Anxiety disorders and depression can interfere with sleep, leading to sleep deficits and impaired driving. Depression, when severe, can cause psychomotor retardation that could slow reaction time. Through these and other mechanisms, mental disorders can result in neurocognitive impairments such as impaired concentration, which could increase the risk of RTA. Finally, medications commonly given for mental disorders have been associated with an increased risk of accidents [63]-[65]; some of this increased risk comes from the underlying conditions and some appears to be an effect of the medication itself [66].

There are at least two other potential mechanisms for the influence of anxiety on risky driving: First, the exhilaration of some risky driving experiences could serve as a simple distraction for some people. In addition, emotional numbing is a cardinal symptom of PTSD, and some individuals who experience this will go to extremes (including deliberate self-harm) to escape this.

The apparent association of combat exposure and risky driving behaviour [67] is entirely consistent with the hypothesis that some of the association is mediated by mental disorders, which also are strongly correlated with combat exposure [60];[68];[69]. That is, combat exposure leads to mental disorders that lead to risky driving, which in turn leads to RTAs.

Thus, there is evidence that anxiety, and perhaps depression, likely mediates some of the association between deployments and RTAs. Some of this effect may be further mediated by psychiatric medications. Unfortunately, there are a number of other potential ways in which mental disorders might lead to risky driving behaviours, so future research will need to explore each of these.

5.6.5 Suicide and Deliberate Self-Harm

Deployment (particularly those involving combat or exposure to atrocities) is commonly perceived to be an important risk factor for suicide. This is certainly plausible: Combat or exposure to atrocities can result

in mental disorders [70] and to suicidal ideation [71]. Nevertheless, a number of studies have failed to confirm a consistently increased risk of suicide in previously deployed personnel [17].

Could some of the excess risk of post-deployment RTAs thus represent suicide? Some of the characteristics of the RTA fatalities in the post-deployment population discussed above could point in this direction (e.g., the excess of single car accidents, collisions with a fixed object). However, there is no excess of single-*occupant* RTA deaths (that is, those involving a driver and no passengers) [35]. In addition, careful review of external causes of death recorded on death certificates in Western countries shows little misclassification, and suicide using a motor vehicle is an uncommon means in industrialized countries [72]-[80]. One would have to hypothesize that misclassification is for some reason far more likely in previously deployed personnel than in non-deployed personnel. Hence, most evidence points away from the hypothesis that the excess of RTA deaths in previously-deployed personnel is due to misclassification of suicides as RTAs.

5.6.6 Sleep Disturbance

A number of factors contribute to motor vehicle accidents, including fatigue and sleepiness. Sleep disturbance is another common symptom of the post-deployment period [81]. It can be a manifestation of an underlying psychiatric disorder (such as depression or PTSD), or it can occur as a more independent problem or symptom [81]. Even modest amounts of sleep deprivation result in significant driving impairments that are comparable in magnitude to driving under the influence of alcohol [45].

For these reasons, sleepy driving is second only to alcohol as a contributor to RTA fatalities [45]; numerous neuropsychological changes contribute to this increased accident risk [82]. The U.S. Army Combat Readiness/Safety Center (CRC) reported fatigue to be one of the leading causes of off-duty ground accidents [83]. The CRC also reports that the majority of off-duty fatigue-related accidents occur between 23:59 and 04:00 hours. No experimental evidence specific to military personnel and fatigue-related accidents was found in searches of published literature and unpublished technical reports; however, a large number of driver fatigue studies focus on shift work employees such as nurses and those who operate motor vehicles for extended periods of time such as long-haul truck drivers and has shown that driver fatigue is a significant risk factor for these populations (e.g., [84]-[86]).

It is logical to infer a positive relationship between driver fatigue and crash risk but the strength of this relationship is unclear. In a systematic review of epidemiological studies of fatigue and motor vehicle crashes, Connor et al. [87] reported that few well-designed research studies of the effect of fatigue on motor vehicle crash risk exist in the literature. They found that some studies provided evidence suggesting a positive relationship between fatigue and crash risk but no evidence of the strength of that relationship. Given the infrequency of quality studies on the topic, they concluded that the existing literature does not provide evidence of a strong or even reliable relationship between motor vehicle crash risk and measures of fatigue with the exception of sleep apnoea. That understood, other lines of evidence strongly support such a relationship (e.g., driving simulator studies on sleep-deprived or fatigued individuals, studies of the effect of sleep deprivation on neurocognitive functions known to be important to driving, the self-reports of accident survivors who report having fallen asleep at the wheel, and accident investigations that strongly suggest sleepiness as the key factor in the accident [46]).

Finally, as noted above, hypnotics often given for sleep problems can also degrade driving performance. Hence, it is plausible that at least some of the effect of deployment on RTA fatalities is mediated by sleep disturbance, some of which is in turn mediated by mental disorders.

5.6.7 Anger/Aggressivity

Anger and aggressivity is another common complaint during the post-deployment period [88];[89], and it can be the consequence of an underlying mental disorder (notably PTSD [90]-[93], a reaction to stressors,

or simply a personal disposition. Anger can trigger aggressive driving behaviours [94], which in turn can lead to accidents [95]. So again, mediation of deployment-related accident risk through anger/aggressivity is plausible (and may be driven by distress and mental disorders), though there are no studies that have explicitly explored this possibility.

5.6.8 Neurotoxicity Related to Deployment-Specific Exposures

Exposure to potential neurotoxins such as insecticides, chemical warfare agents, and pyridostigmine bromide have been suggested as a cause of Gulf War Illnesses [96]. Indeed, fatigue and neurocognitive complaints are among the most common in GWVs [97], and these might lead to an increased risk for RTA. Two studies have has explored this hypothesis directly: Bullman [98] and Gackstetter [32] did not find any increase in the risk of RTA in GWVs exposed to low levels of chemical warfare agents, and Macfarlane [31] found that self-reported exposure to potential neurotoxins did not increase the risk of external causes of death. Hence, there is little evidence to support this hypothesis.

5.6.9 Traumatic Brain Injury

A significant proportion of personnel deployed during the current conflicts have been exposed to Traumatic Brain Injury (TBI), most of which are blast-related and most of which fall into the mild TBI (mTBI) category [99]-[102]. More severe forms of TBI are associated with a high risk neurocognitive deficits that can impair driving abilities [56];[103], but these are uncommon enough [104] that these cannot be driving population-wide deployment-related changes in driving behaviour or RTA mortality.

Fatigue is one of the most commonly reported symptoms among individuals who have had a traumatic brain injury (TBI) [105]. In a longitudinal study by Bushnik et al. [106], participants reported the highest levels of fatigue within 6 months post-injury and showed a pattern of decline in fatigue over the course of a year. Sleep disturbance is another common complaint following TBI [107];[108]. Depression also occurs commonly after TBI [109], even in athletes who presumably are at low risk for psychological trauma after their injury. As noted above, depression is a plausible driver of risky driving behaviour.

The prevalence and origin of long-term symptoms and deficits after mTBI remain controversial. Data from the sports literature [110] clearly shows that virtually all concussed athletes recover completely over the days and weeks after their injury. Data from civilian victims of accidents and assaults [111] tell a more complicated story, with an important minority complaining of persistent symptoms, though objective deficits are distinctly uncommon. In civilian mTBI cases, persistent symptoms are associated with psychosocial factors as opposed to the characteristics of the physical injury itself [112]-[115].

In a recent study at RAND Corporation., an estimated 19.5% of US Soldiers returning from Iraq and Afghanistan have a probable TBI [102]. Those with TBI also tend to report increased sleep disturbances and daytime sleepiness. Thus, indirectly, Soldiers returning from deployment have an increased risk of experiencing fatigue.

Data from military personnel with deployment-related mTBI are accumulating rapidly. These data have consistently shown that persistent symptoms are not uncommon, but they have a much tighter relationship with mental disorders and distress than they do with the after-effects of mechanical brain injury [99];[100];[116]-[120]. Neuropsychological testing has failed to show specific deficits in mTBI-affected personnel in the post-deployment period [118];[121];[122]. Where deficits are seen, they tend to be mild and fully accounted for by co-morbid mental disorders and distress [116]. It thus seems unlikely that TBI is a major mediator of the link between deployment and RTAs.

5.6.10 Risk Tolerance, Sensation-Seeking, and Impulsivity

As mentioned earlier in this report, personality traits such as risk tolerance [123], sensation-seeking [124], and impulsivity [123] are consistently related to risky driving [125] and to a broad range of other health risk behaviours. These traits could explain why such a broad range of risky driving behaviours appears to be influenced by deployment (as discussed above). Many of these traits relate to individual differences in how individuals evaluate and react to risks. Key traits include impulsivity, risk tolerance, and sensation seeking [125]. These traits could be relevant to the issue of deployment and health risk behaviours if:

1) They are a source of bias in research (alluded to above); and
2) If they *change* in response to the experience of deployment.

There is evidence from some populations that these risk-related traits are largely stable over time [126]; [127], at least in civilians exposed to everyday life experience. But combat is not an everyday experience, so it is conceivable that it could alter the way one perceives and evaluates risks. Anecdotally, there is the impression that combat turns soldiers into “adrenaline junkies” who yearn for the “high” they experienced in combat. Post-combat invincibility [20] has been proposed as one potential mechanism for increased post-deployment risk toleration. Indeed, programs have been developed to give previously deployed personnel an opportunity to quench their thirst for excitement in less risky ways, such as through organized adventure training activities [128]. Despite the intuitive appeal of this line of thinking and the known association of sensation-seeking with risky driving [129], there is no hard data to support the assertion that the experience of combat results in significant changes in risk psychology.

Impulsivity is a known risk factor for general risk-taking [130];[131], risky driving [123], and RTAs [132]. As such, changes in impulsivity could explain the increased risk of RTAs after deployment. Several mechanisms are possible: Combat requires split-second reactions, so it is conceivable that that tendency could carry over into the post-deployment period. Indeed, there is evidence that reaction time is indeed decreased in combat veterans [133]. That said, decreases in reaction time may have both positive and negative impacts on RTAs.

In addition, negative emotions such as anger and anxiety (commonly seen post-deployment) tend to increase impulsivity [134]. Positive emotions (joy, elation, relief) also promote impulsivity [134];[135]; these are understandably common early in the reintegration period [136]. Presumably, this elation is short-lived, so it cannot explain the excess RTA mortality seen for at least several years after return from deployment. Finally, alcohol use (increased post-deployment, as we have seen) obviously tends to increase impulsivity [137]. There is also emerging longitudinal evidence that heavy drinking itself can lead to changes in impulsivity and sensation-seeking in young adults [138]. Hence, a bi-directional causal relationship between impulsivity and heavy alcohol use may exist, and this is a potential mediator of the effect of deployment on health risk behaviours. Finally, sleep deprivation results in increased impulsivity and risk-taking [139]. It is thus possible that post-deployment sleep problems [81] mediate the link between deployment and risk-taking.

The emerging data on the role that driving-related anxieties play in the genesis of risky post-deployment driving behaviour [58] provides an interesting foil for this risk psychology hypothesis: If the anxiety is playing an important role, then the risky driving behaviour is not motivated by a desire for increased excitement or arousal. It is instead an effort (albeit a risky one) to *minimize* arousal by driving in a way that is comforting (though dangerous).

To summarize, it is known that risk psychology variables such as risk tolerance, sensation seeking, and impulsivity are all strong predictors of risky driving behaviour. That much is clear. What is unclear is whether the experience of deployment changes these variables enough to account for the observed deployment-related increase in risky driving. If such a link does exist, distress and mental disorders may be an important mediator of the link between deployment and changes in risk psychology.

5.7 SUMMARY OF DEPLOYMENT AND RISKY DRIVING BEHAVIOURS

RTG-164 found relatively consistent evidence that combat deployments increase risky driving behaviours and that these behaviours contribute to the increased risk of RTA fatalities seen in previously deployed personnel. The literature shows a consistent pattern of stronger effects with more combat and weaker or absent effects with less combat. The limited longitudinal data on risky driving [43] (showing if anything a decrease in risk-taking behaviours post-deployment) may be explained by the more limited combat exposure in the study population, which was in Iraq during a relatively stable time. However, it might also indicate that some of the apparent differences in health risk behaviours in deployed and non-deployed cohorts are due to residual confounding as opposed to a direct or indirect effect of deployments.

Theory and research offer many possible explanations for the link between deployment, risky driving behaviour, and post-deployment RTA deaths. At least some of the excess risk is almost certainly mediated by risky drinking behaviour, but exactly how much is not known. Illicit drug use may also play a role, though likely a smaller one. Prescription drugs used for mental disorders and sleep disturbance can impair driving and probably contribute to motor vehicle accidents, though it is not clear how much of the deployment-related risk for RTAs is due to these. Sleep disturbance itself and anger/aggressivity, either as a manifestation of an underlying mental disorder or as an independent problem, are possible mediators, but hard data on how these influence driving in the post-deployment context is limited. Mediation by anxiety or depression is highly plausible, and changes in mood or affect may exert their influence via many other mediators (e.g., sleep disturbance, impulsivity, drug/alcohol use). It is clear that dangerous combat driving behaviours persist in an important minority for at least some time. However, it is not clear how much of this is due to simple habituation, though there is emerging evidence that anxiety is an important driver of this behaviour in the post-deployment period. Mediation by changes in risk psychology variables such as risk tolerance, sensation-seeking, and impulsivity is possible, but there is as yet no evidence that deployment influences these factors. If there is such an effect, distress and mental disorders may be important mediators of changes in risk psychology. In fact, *all* of the likely mechanisms discussed above could be mediated by distress or mental disorders. Significant mediation of deployment-related risky driving through the effect by traumatic brain injury or neurotoxin exposures is unlikely, as is the possibility that suicides are masquerading as RTA fatalities.

Clearly, more longitudinal research (including research that explores the stability of risk psychology variables) is needed. Future research needs to capture the full range of risky driving behaviours, along with the full range of potential mediators, and it should allow for the possibility that different psychological factors influence different risky driving behaviours [140]. Given the potential centrality of distress and mental disorders to the post-deployment increase in risky driving behaviour, these should be measured carefully, and analysis should explore the extent of mediation by these.

The above discussion should make it clear that driving is a complex (and often essential) activity with a complex series of antecedents. The potential motivations for the broad range of risky driving behaviours are broader still. The discussion above expands the range of possible explanations for deployment-related risky driving beyond those documented in recent reports [20];[42];[56]. It is hoped that this broader perspective will translate into better research projects, which in turn will lead to advancements in terms of the prevention and control of post-deployment mortality due to RTAs. A richer understanding of the mechanisms that mediate the relationship between deployment and fatal RTAs is absolutely essential for the development of reliable counter-measures.

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