On the Human Consequences of Terrorism

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Abstract

Terrorist attacks are regarded as low-probability highly-consequential events. What, exactly, are the consequential effects of terrorism? This paper presents a cross-sectional depiction of the death and injury profiles for nine of the most violent terrorism tactics: six types of bombings, mass shootings, combined shootings and explosions, and intentional vehicular assaults. By constructing a composite injury and death profile for each tactic under study, attacks can be ranked in terms of the number of disability-adjusted lives lost and disability-adjusted life years lost. In addition, the human consequences of terrorism as a whole (on an annual basis) are placed in context relative to the global burden of disease and counterterror expenditures.

1 Introduction

Terrorist attacks are regarded as low-probability highly-consequential events. What, exactly, are the consequential effects of terrorism and how are they measured? Terrorism is the use, or threat of use of violence against civilians and inactive military personnel for the purpose of influencing an audience beyond the immediate victims in order to achieve political, ideological, or religious goals.[1] The way that terrorism influences its intended audience is generally measured in terms of casualties, electoral consequences, amount of damage at the site of the attacks, and its impact on economic growth and tourism.

Indeed, a general picture of the electoral consequences of terrorism is emerging from cross-country panel studies. For example, Gassebner et al. (2008, 2011) analyze the relationship between terrorism and cabinet duration for over 800 elections and 115 countries, constituting some 2,400 cabinets in total. They find that the occurrence of terrorism increases the statistical likelihood of a cabinet change in the next election. Moreover, this likelihood is positively related to the number of severe events (involving at least one casualty) and the sum of all fatalities during a given year. These studies examine the effects of domestic and transnational terrorism combined. Two additional cross-country studies focus on the political effects of transnational terrorism alone. Williams et al. (2013) find that when transnational terrorism occurs, parliamentarian governments on the left of the political spectrum are more likely to fail than those on the right, and that this likelihood is increased with the total number killed in any given month. Park and Bali (2017) find that transnational terrorism destabilizes incumbents, with the effect being most profound for autocracies.

By contrast, there are significant difficulties associated with gauging the consequences of

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[1] This definition is an umbrella meant to judiciously capture the definition of terrorism given in Enders and Sandler (2012, p. 4) and the definitions of terrorism used by the U.S. Department of State and the U.S. Department of Defense, as given in Enders and Sandler (2012, p. 6).

terrorism in terms of monetary damages and its effect on economic growth. For example, in the Global Terrorism Database (hereafter, GTD), the measure of the monetary amount of property damages of a recorded attack can be left blank, indicating that an estimate of the damages was unavailable at the time of the coding of the attack, or recorded as "unknown" (START 2018). If recorded, the reported amount of damages can be quite coarse, e.g. indicating a value less than U.S. $1 million. Approximately 99.5% of the terrorism incident entries in GTD leave the property damage associated with an attack blank, or list it as "unknown" or "minor" (likely less than U.S. $1 million).

Moreover, contrary to the conventional wisdom, it is not possible to infer that terrorism has a statistically significant effect on a country's economic growth, owing to cross-sectional dependence between growth and terrorism with yet-to-be-identified common factors (Gries et al. 2011; Gaibulloev et al. 2014). Granted, there are some exceptional individual cases where endemic terrorism has had an effect on the overall economy, such as Israel (Larocque et al. 2010), and others where a particular region has experienced adverse effects, such as the Basque territory in Spain (Abadie and Gardeazabal 2003). With respect to industries, terrorism has an adverse effect on tourism that can spill across borders (Drakos and Kutan 2003). Nevertheless, findings regarding the adverse economic effects of terrorism within a particular region or sector do not imply that such findings will prevail for the economy as a whole. Indeed, once panel data estimates are corrected for the fact that economic growth and terrorism are not sufficiently 'distant' in some social, economic, network, spatial, etc., sense, Gaibulloev et al.'s (2014) findings convincingly remove the economic growth-terrorism nexus from being considered as a highly consequential effect of terrorism.

Undoubtedly, casualties are what put the "terror" in terrorism. At the same time, very little has been done to assess the human consequences of terrorism beyond counts of the number

of deaths and, perhaps, those injured. Indeed, Spagat (2012) notes that, overall, the conflict literature focuses on deaths, likely because of their dramatic consequences, but that more effort needs to be done to measure injuries because they are, "arguably more policy-relevant than deaths, since injuries require ongoing treatment and other policy measures." For example, from 1970-2016 there are, on average, 8,338 deaths and 10,785 injuries annually due to domestic and transnational terrorism combined (START 2018). Injuries outnumber deaths across the combination of domestic and transnational terrorist events recorded in GTD, and injuries far outnumber deaths for transnational terrorism alone at approximately a 3:1 ratio (Sandler et al. 2009). For the purposes of this study, measuring the 'human consequences of terror' involves (i) examining what lies beneath these casualty aggregates, (ii) characterizing how injuries and deaths are distributed according to the most violent tactics employed by terrorists, and (iii) comparing and combining injuries and deaths on an equivalent cardinal scale.

In this way, injuries are placed into context relative to deaths, and terrorism itself can be placed into context in terms of its associated casualties (deaths plus injuries). As part of this process, this paper provides the first cross-sectional depiction of terrorism that accounts for differences in the distribution of injuries across nine types of terrorist attacks: six types of bombings, mass shootings, combined shootings/explosions, and vehicular assaults.[2] These tactics account for 80% of the deaths and 90% of the injuries in GTD. In addition, once this profile is created, it is possible to measure the human consequences for each type of tactic and for terrorism as a whole on an annual basis.

Deaths and injuries due to terrorism were initially placed in context by Sandler et al. (2009) as part of the Copenhagen Consensus project for prioritizing foreign aid. They used Abenhaim et

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[2] Currently, injury profiles are unavailable for assassinations, hijackings, kidnappings, facility/infrastructure attacks, and unarmed assaults. These tactics have relatively few casualties.

al.'s (1992) study of the distribution of injuries and posttraumatic stress disorder resulting from 21 terrorist attacks in France between 1982 and 1987 (20 bombings and one machine gun attack) to construct a composite injury profile for a terrorist attack. By associating each type of injury with a disability weight from the *Global Burden of Disease* (Lopez et al. 2006), Sandler et al. (2009) created an injury profile that is comparable with deaths. This is because the disability weight associated with each injury takes a value in the [0, 1] interval, with a value of zero being commensurate with optimal health and a value of one corresponding to death. Injuries and deaths are therefore measured on a comparable scale. The product of the number of injured, proportion of those injured that experience a particular injury, and the disability weight associated with the injury yields the total 'injuries-as-deaths' or 'injuries-as-lives-lost' associated with the injury. Aggregating this calculation over all associated injuries yields the total injuries-as-deaths for the attack. In this way, Sandler et al. (2009) estimate that one terrorism injury equates to 0.57^{th} of a death. Subsequently, the 0.57 composite disability weight has been used by Sandler et al. (2011), Enders and Olson (2012), Kaplan (2015), Arvanitidis et al. (2016), Hausken (2018), and Baron et al. (2018) to derive combined measures of terrorism mortality and morbidity.

While novel, the limitations of the approach initiated by Sandler et al. (2009) are twofold. First, the injury profile is based on essentially one form of terrorist attack (bombings) and treats all bombings equally in terms of injury profile. Bombings comprise 48% of the incidents recorded in GTD. Until the present study, very little has been generally known about the effects of terrorism on its immediate victims across attack tactics. This gap is addressed by constructing composite injury and death profiles for six types of terrorist bombings (confined-space, open-space, suicide, vehicle-delivery, structural collapse, and structural fire), mass shootings, combined shootings/explosions, and the relatively recent vehicular assaults in crowded areas. For bombings alone the casualty profile depends upon whether the attack takes place in an open or confined

space. Given the number of injuries and deaths associated with a specific tactic, the composite

disability weight can be used to determine the number of *disability-adjusted lives lost* (DALLs)

due to the attack. The DALLs can then be used to calculate the *disability-adjusted life years*

(DALYs) lost to terrorist attacks. DALLs and DALYs are combined mortality and morbidity

measures developed jointly by the World Bank and World Health Organization (hereafter, WHO)

to measure the relative magnitude of healthy lives lost to a disease, injury or disorder. Combining

the DALLs for the 10,785 yearly average injuries with the average of 8,338 lives lost to terrorism

yields the (undiscounted) DALYs lost to terrorism.

Second, a counterfactual exists that has previously gone unaddressed. Specifically,

although a terrorist attack results in physical injuries and mental disorders, the incidence of these

sequelae in the absence of terrorism would not be zero among the survivors. On any given day,

someone breaks their arm, experiences moderate hearing loss, gets burned, etc., or becomes

depressed or experiences a traumatic event that leads to posttraumatic stress disorder (hereafter,

PTSD). Hence, one must also control for the occurrence of injuries and disorders within the

general population. For example, if the prevalence of major depressive disorder (hereafter, MDD)

among the survivors of a terrorist attack is 25% (Salguero et al. 2001), and the yearly onset of

MDD within the general population is 3.9% (ESEMeD/MHEDEA 2000 Investigators 2004), then

among the survivors there was an additional 21.1% (= 25 − 3.9) onset of MDD that can be

attributed to the attack. Note that only PTSD is included in the Sandler et al. (2009) study.

One contribution of this paper is that it provides a picture of terrorism not previous

available: a summary breakdown of the deaths and injuries associated with nine categories of

attack tactics. In creating the first cross-sectional depiction of terrorism injuries by attack tactic,

the paper identifies an additional dimension for assessing different manifestations of political

violence. For example, Conrad and Greene (2015) demonstrate that it is the *quality* of terror, rather

than the quantity, that matters when assessing the "outbidding" theory of competition among terrorist groups. Their analysis is based on categorizing GTD incidents into two ordinal measures of attack quality. The first measure is target severity, with the ranking of severity running in increasing order from (1) infrastructure targets, to (2) combatants (military, police or rival terrorist groups), to (3) citizens, tourists, NGO personnel, and media. The second measure is attack type. Again, in increasing order of severity these measures are (1) infrastructure and unarmed assaults, (2) hostage taking or hijackings, and (3) violent attacks such as assassinations, armed assaults, and bombings. The present analysis illustrates that even those attacks that would qualify as most severe by either ordinal measure substantially differ in terms of cardinal measures of their effects.

An analysis of the nine forms of terrorist attack tactics examined here leads to the following additional results. First, including injuries though the calculation of DALLs increases the human cost of terrorism by over 50% as compared to deaths alone. Second, comparing DALLs across attack categories allows for a ranking in terms of their human consequences. Mass shootings are found to be the most consequential form of attack, with combined shootings/explosions being second. Suicide bombings come in third out of the nine tactics covered. This bolsters evidence that suicide bombings receive disproportionate media coverage after adjusting for various characteristics of attacks, including the number of people killed (Jetter 2017). Third, the present study identifies why vehicular assaults should be of increasing concern. Vehicular assaults are both logistically simple and have significantly higher injury and death profiles as compared to many other forms of terrorism. Fourth, the human consequences of terrorism as a whole (on an annual basis) are placed in context relative to the global burden of disease and counterterror expenditures. For example, when deaths and injuries due to terrorism are aggregated across attack types, terrorism ranks in the bottom 9% of the disabilities, injuries, and disorders considered in the *Global Burden of Disease* (Murray et al. 2012). Terrorism is

therefore shown to be a low probability event with low consequences, as measured by its global burden. In this way, preexisting work that is circumspect about the risk and effectiveness of terrorism (e.g., Abrahms 2006; Wilson and Thompson 2005) is corroborated using entirely different data and methods for assessing the consequences of terrorism.

2 Data

This study considers only the direct human consequences of a terrorist attack. That is, those individuals who lost their lives, were injured, or experienced a mental disorder owing to their physical presence at the site of the attack. Electronic witnesses of the event via television, the internet, or other means, and the effect on the relatives and households of the direct victims are not considered.

Understanding this, the steps involved in combining terrorism injuries with deaths are as follows. First, identify the frequency of different types of injuries associated with different types of terrorist attacks. Second, map these injuries into the categories that receive disability weights (DWs) in the *Global Burden of Disease* (Salomon et al. 2015) – hereafter, *GBD*. Third, identify the number of injuries associated with a given type of terrorist attack. Fourth, combine steps one, two, and three in order to arrive at the number of lives lost due to disability (LD) associated with each terrorist tactic. Fifth, combine the LD with the number of lives lost (LL) associated with a given tactic to arrive at the number of disability-adjusted lives lost (DALLs = LL + LD) for the tactic. Finally, given the life expectancy of terrorism victims, one can compute the DALYs lost for specific terrorist tactics as well as for terrorism as a whole. Consequently, data are needed on (i) the injury profile for each tactic, (ii) the disability weight associated with each type of injury, (iii) the number of injuries and deaths associated with each tactic, (iv) the age profiles of victims, and (v) years of life expectancy lost to premature death or injury. In addition, in order to provide

a counterfactual, the incidence of each type of injury within the general population is needed.

In summary, data are needed in order to calculate the following:

$f_i \equiv$ frequency of disability/injury/disorder 'i,' where $0 \le f_i \le 1$.

$DW_i \equiv$ disability weight for disability/injury/disorder 'i,' where $0 \le DW_i \le 1$.

$LD_i \equiv$ number of injuries-as-lives-lost to disability/injury/disorder 'i.'

$LD \equiv$ total injuries-as-lives-lost to a terrorist tactic (attack category).

$LL \equiv$ total lives lost (deaths) to a terrorist tactic (attack category).

$DALLs \equiv$ total disability-adjusted lives lost to a terrorist tactic ($DALL = LD + LL$).

$DALYs \equiv$ total disability-adjusted life years lost to a terrorist tactic.

In reality, data are exceedingly scarce on the breakdown of injuries resulting from particular types of terrorist attacks. In the major terrorism databases, often all that is recorded is the number of casualties (those killed or injured). Yet data on the associated frequency of injuries, f_i's, are needed to calculate DALLs and DALYs. A contribution of this paper is that it leverages data from multiple sources, typically, epidemiological meta- or multi-year studies of the injury profiles of different terrorist attack tactics. This profile data is then used to make predictions on the breakdown of injuries by tactic, as, in general, this information is not directly available. These data sources are discussed below, as are the nature of and sources for the disability weights.

2.1 Injury profile

The distribution of each type of injury associated with each type of attack is summarized in Table 1. The sources for these data are discussed in this subsection. Injuries are organized as listed in Table 1 because bombing injuries fall into four categorizations (Edwards et al. 2016): primary blast pressured-induced (blast lung, tympanic membrane), secondary effects of projectiles (thorax, abdominal, head and neck, extremity, spine), tertiary (limb fracture, limb

amputation), and quaternary (burns).

[Insert Table 1 Here]

In addition, in examining Table 1 it is clear that, for a given tactic, the overall percentage of injuries sustained can sum to a total that is in excess of 100%. This is because many victims sustain multiple injuries. Moreover, certain tactics lead to more multiple injuries than other tactics. For these reasons, the occurrence of multiple injuries is important information that should not be arbitrarily ruled out by normalizing injury frequencies so that they sum to 100% for a given tactic. For example, survivors of vehicular assaults have, in general, been struck by the largest 'projectile' – a vehicle – and are subject to more multiple injuries than any other form of terrorist tactic considered here. For vehicular assaults, the sum of the frequency of all injuries in column (7) of Table 1 is 274%. Multiple injuries are clearly a consequence of vehicular assaults. The method used for dealing with multiple injuries when making DALY calculations is addressed below.

Edwards et al. (2016) conduct a meta-study of the injury profiles of 167 terrorist bombings world-wide from 1970-2014. In so doing, they find significant differences in the injury profile for bombings taking place in open versus confined spaces. For example, the primary (pressure-induced) injuries associated with bombings increase within confined areas because of the effects of reflections or reverberations (DePalma et al. 2005). By contrast, open-space bombings do not result in a great degree of primary blast injuries because the associated pressure dissipates in the absence of fixed boundaries. These differences can be seen by comparing the primary blast data rows in columns (1) and (2) of Table 1. The injury profile for suicide bombings in column (3) comes from a different data source. Yasin et al. (2012) provide data from a three year study of 1,296 multiple injuries from suicide bombing victims hospitalized in Rawalpindi, Pakistan. Their study is used because their injury categorization is comparable to that in Edwards et al. (2016).

Suicide bombings differ significantly from conventional bombings in terms of both their mortality and injury profiles (Hicks et al. 2011; Santifort-Jordan and Sandler 2014).

Comprehensive accounts of injuries sustained in terrorist mass shootings are given in Peleg et al. (2004), Sheffy et al. (2006), and Turner et al. (2016). Turner et al. (2016) is a meta-study of 17 mass casualty shootings world-wide during 1980–2016. Their study is not restricted to terrorist incidents, whereas Peleg et al. (2004) and Sheffy et al. (2006) are studies of terrorism-related mass shootings in Israel. Only the Israeli studies include information on the types of injuries sustained, with the injury classifications in Sheffy et al. (2006) being the most comparable with the other analyses in this study. Sheffy et al.'s (2006) data, which covers 2000–2004 and 553 victims, are given in the fourth column of Table 1. Interestingly, the overall death rate of 33.3% in Sheffy et al. (2006) is exactly that given for mass-casualty shootings in Turner et al. (2016).

Incidents where terrorists used a combination of firearms and explosives in a public place include the 60-hour attack in Mumbai during 2009, and the Paris concert area attack of November 2015. Malik et al. (2009) provide injury data for an attack within a mosque in Quetta, Pakistan on 4 July 2004 with 94 victims in which 78.5% of the injuries resulted from gunshot wounds and the remaining 21.5% from explosives. Given that the injury categories in Malik et al. (2009) are comparable in detail to the other studies employed here, their data are used for attacks that combine gunshots/explosives. See columns (5) and (6) of Table 1. Note that these numbers are actually below the casualty counts for the attacks in Mumbai (Bhandarwar et al. 2012) or Paris (Gregory et al. 2016).

Finally, during 2016–2017 a rash of vehicular assaults occurred in which a terrorist intentionally plows a moving vehicle into an area crowded with pedestrians such as a market or bridge. Unfortunately, Israel has had significant prior experiences with this tactic. In particular, Almogy et al. (2016) provide injury data for 29 intentional vehicular assaults in Jerusalem from

October 2008 to May 2016. This tactic inflicts the greatest number of multiple injuries on survivors, as detailed in column (7) of Table 1.

2.2 Mental disorders

In addition to physical injury, survivors of terrorist attacks are known to experience mental disorders such as PTSD and MDD. PTSD occurs at about double the rate in survivors of terrorist attacks versus survivors of motor vehicle accidents (Shalev and Freedman 2005). In their meta-study of 113 articles on the behavioral consequences of terrorism world-wide, DiMaggio and Galea (2006) find that an average of 18% of terror survivors experience PTSD. Salguero et al.'s (2011) meta-study of 736 direct terror victims finds that 25% experience MDD. These proportions are assumed to hold across all columns/forms of terrorist attacks in Table 1, with the exception of mass shootings (column (4)). For this column the findings given in Stene et al. (2016) for the survivors of the mass shooting in Utøya, Norway on 22 July 2011 are used. Their figures are 7.7% for PTSD and 24.5% for MDD. All of the data for PTSD and MDD are for persistence of the disorder for at least one year following the attack.

2.3 Disability weights

In order to compare injuries with lives lost, each injury category in Table 1 needs to be assigned a *disability weight* (*DW*). For each injury, '*i*,' $DW_i \in [0,1]$. This allows for injuries and lives lost to be expressed in a comparable cardinal scale. For example, hearing loss is often associated with bombings. In Table 2, the row labeled as tympanic membrane gives the disability weight associated with moderate hearing loss as 0.027 and that for profound hearing loss as 0.204. The *health state* of an individual is $1 - DW_i$. Consequently, an individual with profound hearing loss experiences 1 − 0.204 = 76.9% of optimal health whereas one with moderate hearing loss

experiences $1 - 0.027 = 97.3\%$ of optimal health. Disability weights are regarded to be constant across countries for a given injury/disease/disorder.

[Insert Table 2]

First determined in 1990 by the World Bank and WHO, the values of disability weights are obtained via a panel of judges, and are meant to reflect the relative desirability of a health state for a given clinical description of a disability, injury, or disorder (Haagsma et al. 2014). Choice-based methods that panelists use to assess health states include standard gamble and time tradeoff (Brazier et al. 2017). An assessment for the panel is derived from statistical analyses of individual panelist's responses. In the *standard gamble* a panelist is given a choice between (a) living in the health state associated with 'i,' for the last h years of their life, or (b) undertaking a procedure that will be fully restorative for those h years but carries a probability, p_i, of immediate death. Various tradeoff exercises involving different values of p_i are presented in order to assist a panelist in selecting a value of p_i that induces indifference between options (a) and (b). A *time tradeoff* elicitation process facilitates the panelists' identification of the number of years of perfect health, y_i, that would make them indifferent to h years in health state 'i,' where $y_i < h$. In addition, methods exist for separating out panelists' confounding factors, such as risk aversion from p_i, and rate of time preference from y_i.

Finally, health state values are rescaled to lie between 0 and 1 and turned into the associated disability weight. The disability weight is calculated as $1 -$ health state value. Specifically, for standard gamble, $DW_i = p_i$, and for time tradeoff, $DW_i = 1 - y_i/h$. It is important to keep in mind that one *cannot* simply invert these formulas in order to arrive at an alternative tradeoff-based interpretation of the disability weight in terms of p_i or y_i. As they are not measured in terms of epidemiological data (incidence, prevalence, etc.), disability weights are a means to an end. In this study, the disability weights are used in combination with the frequency

of a particular disability/injury/disorder for a terrorist tactic in order to arrive at summary measures of the associated health consequences (DALLs and DALYs). These in turn will be used to measure the human consequences of terrorism.

Unfortunately, many of the injuries in Table 1 do not have an exact corresponding disability category in *GBD*. For this reason a range of minimum and maximum values for each injury is considered, as detailed in Table 2. The ranges for the number of lives lost due to disability (LDs) for different types of terrorist attacks are calculated by using the minimum disability weights given in Table 2 and then again by using the maximum disability weights in the table. In this way, a range of LDs is calculated for each tactic. In addition, at present *GBD* does not contain disability weights for PTSD. The PTSD disability weights derived in Charlson et al. (2016) and Haagsma et al. (2011a) are used for the minimum and maximum values, respectively.

2.4 Casualties

The deaths and injuries for each tactic are presented in the upper section (first two rows) of Table 3. Arnould et al. (2003) give the median deaths and injuries for six different types of bombings using world-wide data for 43 events. These are the data for the first two rows of columns (1)–(6). The sources for the deaths and injuries in columns (7)–(9) have been discussed above. Note that the Arnould et al. (2003) bombing study is for mass-casualty events involving 30 or more casualties, hence, it is a study of 'spectaculars' and this must be kept in mind. At the same time, these bombings are being compared to data for mass shootings and combined shootings/explosions, both of which are mass casualty tactics, by definition. A comparison is therefore being made across spectacular versions of these tactics.[3] The first two rows of Table 3

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[3] A 'spectacular' representation of recent intentional vehicular assaults is derived in Table 4 below.

must therefore be understood as an upper estimate of the human consequences of terrorism.

[Insert Table 3]

In comparing the categories it is easy to see that suicide bombings cause more casualties than any other type of bombing. By comparison, mass shootings and combined gunshot/explosion attacks cause more casualties than suicide bombings. Combined attacks are logistically complex, therefore, they are inherently designed to produce mass casualties.

3 Lives lost to terrorism injuries

The imputed number of lives lost to disability/injury/disorder 'i,' LD_i, is calculated as follows. Given the associated disability weight, DW_i, and number of individuals with the sequela, N_i, LD_i = DW_i*N_i. For specific terror events, the number of individuals with a particular sequela, N_i, is generally not known. Instead, what is known is the total number of injured, N, and the frequency of a particular sequela, f_i, is provided for the first time in Table 1. Consequently, $N_i = f_i*N$. It follows that $LD_i = DW_i*f_i*N$.

Many terror survivors experience multiple injuries. There are two primary methods for addressing comorbidity across injuries (Mathers et al. 2006, Haagsma et al. 2011b). One method is to assume that the total disability weight is the sum of the separate disability weights. For the *additive method*, $DW_{i+j} = DW_i + DW_j$. An alternative is to realize that the *health state* of an individual experiencing sequela 'i' is $1-DW_i$. If one assumes that experiencing combined sequela is more severe than experiencing either on its own, this is akin to the health state values, $1-DW_i$ and $1-DW_j$ being multiplicative. Hence, the associated disability weight for the *multiplicative method* is $DW_{i*j} = 1 - (1-DW_i)*(1-DW_j)$. The multiplicative method has the advantage that it is always the case that $DW_{i*j} \in [0,1]$, whereas for the additive method it is possible that $DW_{i+j} > 1$

(death). This contingency is addressed below.

Given the total number of types of injuries, I, associated with a particular tactic, the aggregate LD for the tactic when using the additive method is:

(1) $\quad LD = DW_1 * f_1 * N + DW_2 * f_2 * N + \ldots + DW_I * f_I * N = N * \underbrace{\sum_{i \in I} DW_i * f_i}_{Composite\ DW^+}$.

For any given tactic, the associated LD will vary with the number of injured, N. Hence, what is common for calculating the lives lost to disability for a specific tactic is the term $\sum_{i \in I} DW_i * f_i$.

This term defines the *composite disability* weight, DW^+, for a given tactic when using the additive method to account for comorbidity. Consequently, if the number of injuries for a terrorist attack is known and the tactic is one of the nine types analyzed here, then the composite disability weight provided by this study can be used to determine the LD for the attack. Such an example is given below for the 2016–2017 spate of intentional vehicular assaults.

Disability weights for individual injuries fall in the [0, 1] interval. By definition, the frequency values for a specific injury 'i,' f_i, also lies within the same interval. However, owing to the presence of multiple injuries, it is possible that the sum $\sum_{i \in I} f_i > 1$. For example, for vehicular assaults the sum of the injury frequencies is 2.74. This means that it is also theoretically possible for the composite disability weight to be greater than one. Yet it must be the case that the composite disability weight takes a value that is less than or equal to one because a value of one corresponds to death. Consequently, when using the additive method, if the composite disability weight for an attack type exceeds one, the disability weight will instead be reduced to a value of one. In this study there is one and only one instance of this phenomenon: the composite disability weight for vehicular assaults when the maximum disability weight is used for each type of injury (see Table 3).

A composite disability weight can alternatively be calculated by applying the multiplicative method to the disability weights for each injury. Specifically,

$$(2) \quad LD = N * \underbrace{\left[1 - \prod_{i \in I}\left(1 - DW_i * f_i\right)\right]}_{Composite\ DW*}$$

where $\prod$ is the product operator. The composite disability weight using the multiplicative method to account for comorbidity is denoted as $DW*$. It is always the case that $0 \le DW* \le 1$.

A comparison of composite disability weights for the additive and multiplicative comorbidity methods is given in the appendix (Table A1) for different types of terrorist attacks. When the minimum disability weights for injuries are used, the two methods are quite close, with an average absolute difference of 0.0090 across the attack types. For the maximum disability weights, they are further apart, with an average absolute difference of 0.1809. Given that Haagsma et al. (2011b) find that the interclass correlation coefficient between observed and predicted comorbidity disability is highest for the additive approach, the additive composite disability weight, DW^+, will be used in all calculations from this point forward.

Finally, in calculating LD no adjustment is made for duration of injury because LD is already biased downward for several reasons. First, the injury frequencies reported in the studies cited in Table 1 are only for those survivors who were hospitalized. There is therefore an undercount of the number of injured and their injuries. Second, it is known that there are large numbers of non-victims who suffer psychologically in the aftermath of a terrorist event. In a meta-study of this phenomenon, Salguero et al. (2001) find that the risk of MDD in non-victims after a terrorist attack lies between 4 and 10% for the adult population where the event occurred. Lastly, Kerridge et al. (2012) find evidence that terrorism can have negative effects on public

health beyond sequela experienced by the immediate victims and this is unaccounted for.[4]

It follows that, given the number of lives lost, LL, the number of disability-adjusted adjusted lives directly lost for a terrorist event is:

(3)   DALL = LL + LD.

The difference between DALLs and DALYs is that no adjustment has yet been made for the *years of life expectancy lost by the terrorism victims*, Y. Given Y, the (undiscounted) *years lived with disability*, YLD, is YLD = LL∗Y and the (undiscounted) *years of life lost due to death*, YLL, is YLL = LL∗Y. The formula for (undiscounted) disability-adjusted life years, DALY = YLL + YLD, can therefore be expressed as

(4)   DALY = YLL + YLD = LL∗Y + LD∗Y = (LL + LD)∗Y = DALL∗Y.

Finally, the counterfactual to an injury that occurs due a terrorist event is *not* no injury. Many of the injuries – and especially the mental disorders – associated with terrorist events also occur in the population at-large. As such, one has to consider the frequency of injury '*i*' within the population (per 100 persons), $\hat{f}_i$. Consequently, the *counterfactual net frequency of injury '*i*'* is $f_i - \hat{f}_i$. Given this counterfactual, the net lives lost to disability '*i*' are

(5) $\widehat{LD}_i = N_i * DW_i * \left(f_i - \hat{f}_i \right).$

The frequency of an *injury per 100 persons*, $\hat{f}_i$, can be extremely low. In order to avoid scientific notation, injury frequencies are commonly reported on a per 10,000 or 100,000 person basis. For example, $\hat{f}_i$ is zero for primary blast injuries because, "bombs and explosions cause unique patterns rarely seen outside of combat" (CDC 2016). By contrast, the onset of mental disorders within the general population during a 12-month period is significant. The

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[4] See Ghobarah et al. (2003) for the effects of civil war on public health.

ESEMeD/MHEDEA 2000 Investigators (2004) put the 12-month onset of MDD at 3.9% for adult Europeans and for PTSD they put it at 0.9%. The implication is that if 25% of the survivors of a terrorist bombing experience MDD, this is actually a net increase of $21.1\% \, (f_i - \hat{f}_i = 25 - 3.9)$ that can be attributed to the terrorist event. Similarly, the 18% who experience PTSD represent an attributable net increase of 17.1% (= 18 − 0.9). The data for the counterfactual calculations are given as an appendix (Table A2).

4 Results

The casualties for nine different types of terrorist attacks are given in the first two rows of columns (1)–(9) of Table 3. Examining these two rows alone makes it clear that attack tactics vary substantially in terms of both the distribution and numbers of deaths and injuries.

4.1 Composite disability weights for terror attacks

The middle section of Table 3 begins with the composite disability weights, where the term 'composite' means that the disability weight is an aggregation of the frequency of injuries sustained for a given type of terrorist attack. At this point, no control is used for the counterfactual, which is the frequency of the injuries in the general population in the absence of terrorism. In calculating the composite disability weight, either the minimum disability weight values for all injuries are used or the maximum disability weight values are used (refer to Table 2). For example, as measured by the composite disability weight, each injury sustained in a confined-space bombing ranges between 0.0895^{th} and 0.5414^{th} of a life lost. The finding of one injury equating to 0.57^{th} of a life lost by Sandler et al. (2009) falls just outside this range but it does fall within the range of 0.1061^{th} to 0.6391^{th} of a life lost for open-space bombings. Suicide bombings cause injuries that range between 0.1419^{th} and 0.9759^{th} of a life lost (column (3)). The

composite disability weight in column (7) for mass shooting ranges between 0.113[th] of a life lost to 0.631. For attacks that combine gunshots/explosives, the range for disability weights is 0.1562 to 0.4909. Intentional vehicular assaults, which have become increasingly popular with Islamic State-inspired terrorists, lead to injuries that range from 0.2531[th] to 1.0 of a life lost.

When the composite disability weight is multiplied by the number of injuries, the result is the number of lives lost due to disability. This is then added to the number of lives lost to determine the number of DALLs for a given type of terrorist attack. By comparing DALLs one can see that, on average, the form of terrorist attack with the greatest human consequences is mass shooting, with a DALL of 100.76. The second-most consequential form of terrorism is an attack that combines shootings/explosions (DALL = 59.50). Mass shootings are twice as consequential as suicide bombings (DALL = 50.30), which is the third highest form of attack analyzed here. This lower ranking of suicide bombings should not be surprising given Jetter's (2017) recent findings that, (i) "suicide attacks receive more media coverage purely for being suicide attacks," even when controlling for deaths, and (ii) in terms of media coverage, a suicide attack is equivalent to an alternative attack that generates 95 deaths. Hence, suicide attacks should not be expected to be at the top of the DALLs ranking because the suicide aspect substitutes for casualties as a means for gaining media attention.

4.2 Controlling for the counterfactual

The bottom section of Table 3 controls for the counterfactual that, in the absence of a terrorist event, some of the victims would still have experienced an injury or mental disorder. On average, the effect of this counterfactual is to reduce the composite disability weight for conventional bombings by 15%, suicide bombings by 12.73%, mass shootings by 26.4%, attacks that combine shootings/explosions by 18.95%, and vehicular assaults by 13.73%. Controlling for this

counterfactual has a qualitatively significant impact on the composite disability weights.

4.3 Application to vehicular assaults

The methodology introduced above can be used to assess the recent rash of vehicle assaults, as indicated in Table 4. "Following the (vehicular assault) attack in Nice that killed 86 people in July 2016, the Islamic State published a guide for would-be attackers, noting that vehicles are 'extremely easy to acquire' and unlikely to arouse the suspicions of citizens or authorities" (Clarke and Klarevas 2017). This representation of vehicular assaults is more in line with the spectacular nature of the casualties given for the first eight tactics in Table 3. These recent vehicular assaults have a median DALL of 36.71, making them the fourth-most consequential form of terror attack relative to the DALL calculations in Table 3. Given the logistical ease of intentional vehicular assaults, and their associated consequences when conducted at the scale currently experienced, this is likely a harbinger of the future of terrorism.

[Insert Table 4]

5 The human consequences of terrorism in context

The purpose of DALYs is to provide a summary measure of the relative *burden* (healthy life years lost) for different diseases, injuries, and disorders. The data and methodology introduced above allow for a determination of the burden of a terrorist attack, as measured by DALYs. Undiscounted DALYs are equal to the product of disability-adjusted life years and the years of life expectancy lost by the victims: $DALY = DALL*Y$. The value used for years of life expectancy lost, Y, is the number of years of life expectancy lost for the median or mean age of terror victims. Once again, a range of values is considered. Specifically, in Stene et al. (2016) the mean age of the victims of the Utøya mass shooting was approximately 19 years old. Almogy et

al. (2016) report a mean age of 24.7 for vehicular assaults in Israel. For the Oklahoma City

bombing in the U.S., Mallonee et al. (1996) give a median age of 39. In addition, for the attack to

be truly representative of the civilian population, it is assumed that 50% of the victims are female.

Life expectancy data for each country come from the World Bank.

[Insert Table 5]

The DALY ranges for individual types of attack are given in Table 5. The injury

counterfactual is not used, as DALYs are most often presented without this counterfactual, and

the DALYs for terrorism will be compared with those for other phenomena. The DALYs for an

individual type of attack range from 368 years to 6,348 years. As is the case for DALLs, the form

of terrorist attack with the largest DALY is mass shootings, followed by combined

shootings/explosions, suicide bombings, and the recent spate of intentional vehicular assaults.

5.1 The global burden of terrorism

In order to derive the burden of terrorism for a particular year, consider the following exercise.

Using the GTD dataset, 8,338 deaths due to terrorism occur per year (1970–2016). In addition,

10,785 injuries due to terrorism occur annually. These totals are given in the final column of

Table 6. As Table 6 is comparing aggregates, rather than individual tactics, the deaths and injury

data come from GTD instead of the first two rows of Tables 3 or 5. Deaths and injuries are

allocated to each tactic according to a normalized percent of total deaths and injuries within GTD

among the nine tactics. For example, suicide bombings constitute 16.86% of the deaths within

the nine types of attack examined, and 22.53% of the injuries. Combined shootings/explosions

constitute 15.47% of the deaths and 9.5% of the injuries, and vehicular assaults constitute 1.04%

of the deaths and 3.39% of the injuries. GTD distinguishes between suicide and non-suicide

bombings, but does not further refine bombings amongst closed-space, open-space, vehicle

delivery, and structural collapse. Hence, non-suicide bombings, which constitute 23.64% of the deaths and 52.23% of the injuries, are assumed to fall uniformly across these four tactics (5.91% of the deaths and 13.06% of the injuries each).

[Insert Table 6]

The results of this exercise are given in Table 6. By accounting for injuries, the annual average of 8,338 lives lost to terrorism is increased to 12,628 disability-adjusted lives lost. This represents a 51% increase in the measured number of lives lost to terrorism annually. By contrast, the annual DALYs for terrorism as a whole range from 502,056 to 798,984, with a median value of 726,695. This is an extremely low burden of disease. If terrorism was a disease, injury, or disorder, its DALY would rank it in the bottom decile of the 291 diseases and injuries ranked in the *Global Burden of Disease* (Murray et al. 2012). Specifically, in Table 7 it is shown that terrorism would rank 266th, i.e. in the bottom 9%. Relative to the diseases that plague mankind, terrorism has limited consequences.

[Insert Table 7]

5.2 The counterterror context

Counterterror expenditures are ultimately designed to save lives and this study quantifies the casualties attributed to terrorism. Moreover, recall that Gaibulloev et al. (2014) use a panel dataset to show that it is unlikely that terrorism has a significant effect on economic growth. In addition, the data on damages is so coarse that 99.5% of the entries in GTD provide no specific damage figures, with 76% of the total listed as "unknown" or left blank. Hence, the immediate consequences of terrorism are primarily human, consistent with the focus of this paper.

Consider, therefore, the following calculation. The September 11th Victim Compensation Fund was tasked with determining compensation for the families of the deceased associated with the events of 9/11. The average award for a death claim ended up being approximately $2

million (Feinberg 2006). During the same period, public spending on homeland security in the U.S. alone rose from $20.1 billion per year in 2001 to $54.3 billion per year in 2005 (Hobijn and Sager 2007). Taking $2 million per life as a benchmark, this works out to DHS expenditures to save roughly 28,500 lives per year.[5] This counterfactual is consistent with the following well-known statement contained in the 911 Commission Report (U.S. Congress 2002): "terrorists need to be successful only once to kill Americans and demonstrate the inherent vulnerabilities they face." By contrast, there are a total of 12,628 disability-adjusted lives lost to terrorism per year world-wide, of which but a fraction are U.S. citizens. This implies a benefit-cost ratio no greater than 0.44 (= 12,628/28,500). Granted, disability weights and DALYs have been designed with the allocative efficiency of health interventions in mind, but this level of inefficiency does give one pause as to the underlying rationale for counterterrorism expenditures.

6 Conclusion

This paper provides the first cross-sectional depiction of the effects of terrorism by type of attack tactic. In particular, it presents the injury and mental disorder profiles for nine types of terrorist attacks: confined-space bombings, open-space bombings, suicide bombings, vehicle delivered bombings, structural collapses due to bombings, structural fires due to bombings, mass shootings, attacks that combine shootings/explosions, and vehicular assaults. Those with the most casualties, as measured by disability adjusted lives lost, are mass shootings, combined shootings/explosions, suicide bombings, and the recent phenomenon of vehicular assaults.

These rankings are possible because composite disability weights are also derived for each type of attack, which facilitates getting past counts of the number of deaths and injured

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[5] GTD does not provide data on foiled attempts or plots because an, "attack must actually be attempted to qualify for inclusion in the database" (START 2018).

alone. This provides a clearer picture of the human consequences of terrorism. Examining terrorism through the lens of casualties (deaths + injuries) leads to a different ranking of terror tactics than ranking by deaths alone. In addition, the ability to combine deaths and injuries into one useful measure prevents injuries from being viewed as separate from or incomparable to deaths, thereby providing a comprehensive overall picture of the human consequences of terrorism. For example, instead of observing that there 8,388 deaths and 10,785 injuries annually due to terrorism, it is now possible to state that there are 12,682 disability-adjusted lives lost annually to terrorism. This is a 51% increase in the average number of deaths attributed to terrorism absent the injury count. It also removes ambiguity regarding how to place injuries in context.

At the same time, the impact of terrorism is placed into context against two standards. For a representative year, the median number of disability-adjusted life years lost to terrorism is 486,378. That is, terrorism lies in the bottom 9% of the global burden of disease. Similarly, it is shown that the benefit-cost ratio for DHS counterterror expenditure can be no greater than 0.44.

This suggests that a significant portion of counterterror expenditure is non-instrumental. That is, its rationale includes something other than its effect on terrorists. For example, cross-country panel analyses suggest that terrorism increases the statistical likelihood of cabinet changes in parliamentary governments. This implies that counterterror policy has a role to play as a form of organizational and/or coalitional maintenance for those currently holding power. Indeed, Coates et al. (2007) show that the distribution of DHS funds among U.S. states can be partially explained by the electoral votes per capita of a state, rather than being more directly tied to each state's vulnerability to terrorism. Research is therefore needed into the fundamental tension between the instrumental and political goals of counterterror policy. In this sense, counterterror policy may be no different than terrorism itself, which also has non-instrumental

rationales geared towards maintaining terrorist organizations.

Finally, the data and techniques presented here allow for a much more thorough treatment of the effects of terrorism injuries beyond their use as count data. The injury profile data assembled here can better prepare emergency rooms for the types of injuries likely to be admitted in the immediate aftermath of a given type of terrorist attack. In addition, the cost of injuries has been expressed in terms of deaths. An alternative measure would be the cost of treatment, which presumably differs for blast lung injuries versus broken femurs versus major depressive disorder, etc. Moreover, it is much more likely that the degree to which terrorism acts as system stressor, such as on public health, is due to the diversion of resources to the injured, rather than deaths, because the treatment and care of the injured is ongoing, and is not limited to healthcare professionals.

Appendix: additional tables

[Insert Table A1]

[Insert Table A2]

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Table 1 Injury and disorder profiles by type of attack
[Percentage of injured experiencing sequela]

SEQUELA	(1) BOMBINGS Confined Space[1]	(2) Open Space[1]	(3) Suicide[2]	(4) Mass Shootings[3]	(5) Combined[4] Gunshot Victims	(6) Explosion Victims	(7) Vehicular Rampage[5]
PRIMARY BLAST INJURY							
Blast Lung	7.55%	5.54%	10.90%				
Tympanic Membrane	26.61%	1.45%	33.00%				
SECONDARY INJURY							
Thorax	7.17%	66.42%	33.00%	23.5%	7.5%		12%
Abdominal	3.96%	1.73%	42.00%	25.8%	12.5%		11%
Head, Neck (and Face)	18.73%	7.47%	18.00%	35.0%	10.0%	18.2%	81%
Extremity	12.59%	20.09%		58.9%			84%
Spine			2.60%	8.6%	15.0%	27.3%	27%
TERTIARY INJURY							
Limb Fracture	11.47%	18.42%					
Limb Amputation	1.81%	4.15%	9.70%				
Upper Limb			15.84%		40.0%	45.5%	
Lower Limb			32.16%		62.5%	45.5%	
Other							59%[6]
QUATERNARY INJURY							
Burns	20.38%	21.28%	51.00%	2.5%			
MENTAL DISORDERS							
Posttraumatic Stress (PTSD)[7]	18.0%	18.0%	18.0%	7.7%[9]	18.0%	18.0%	18.0%
Major Depressive (MDD)[8]	25.0%	25.0%	25.0%	24.5%[9]	25.0%	25.0%	25.0%

[1] Edwards et al. (2016). [2] Yasin et al. (2012). [3] Sheffy et al. (2006). [4] Malik et al. (2009). [5] Almogy et al. (2016).
[6] Skin (27%), Pelvis (12%), Vascular (12%), and Ocular (8%). [7] DiMaggio and Galea (2006). [8] Salguero et al. (2001). [9] Stene et al. (2016).

Table 2 Disability weights (DWs) for terrorism sequelae

Sequela[1] (i)	Minimum DW_i Category	Min DW_i	Maximum DW_i Category	Max DW_i
Abdominal	Mild abdominopelvic problem	0.011	Severe abdominopelvic problem	0.324
Blast Lung	Mild chronic obstructive pulmonary disease and other chronic respiratory diseases	0.019	Severe chronic obstructive pulmonary disease and other chronic respiratory diseases	0.408
Burns	< 20% of total surface area or < 10% if head, neck, hands or wrist	0.016	≥ 20% of total surface area or ≥ 10% if head, neck, hands or wrist.	0.455
Extremity	Hand facture: short term, with or without treatment	0.010	Foot bone fracture: short-term, with or without treatment	0.026
Head and Neck	Fracture, face bone	0.067	Spinal cord lesion: at neck, treated	0.589
Limb Amputation	One arm: with or without treatment	0.039	Both legs: with or without treatment	0.088
Limb Fracture	Radius or ulna fracture: without or without treatment	0.028	Neck of femur fracture: with or without treatment	0.058
Lower Limb	Neck of femur fracture: with or without treatment	0.058	Other than neck of femur fracture: with or without treatment	0.111
Upper Limb	Radius or ulna fracture: without or without treatment	0.028	One arm amputation: with or without treatment	0.039
Spine	Spinal cord lesion: below neck, treated	0.296	Spinal cord lesion: at neck, treated	0.589
Thorax	Severe chest injury: long-term with or without treatment	0.047	Severe chest injury: short-term with or without treatment	0.369
Tympanic Membrane	Moderate hearing loss	0.027	Profound hearing loss	0.204
██████████████████				
MENTAL DISORDER				
Major Depression[1]	Mild episode	0.145	Severe episode	0.658
Posttraumatic Stress	Conflict-Affected populations[2]	0.110	Netherlands ER patients with unintentional injuries[3]	0.211

[1] DW Source: Salomon et al. (2015)

[2] DW Source: Charlson et al. (2016)

[3] DW Source: Haagsma et al. (2011a)

Table 3 Disability-adjusted lives lost (DALLs) to terrorism by type of attack

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BOMBINGS[1] (Median Values)						Mass Shooting[4]	Combined Gunshot & Explosion[5]	Recent Vehicular Assaults[6]
	Confined Space	Open Space	Suicide	Vehicle Delivery[2]	Structural Collapse[3]	Structural Fire[3]			
Deaths: Lives Lost (LL)	4	1	19	5	21	20	57.6	43	6
Injuries	51	13	56	18	38	51	116.0	51	48
NO COUNTERFACTUAL									
Min Composite DW	0.0895	0.1061	0.1419	0.1061	0.0895	0.0895	0.1130	0.1562	0.2531
Max Composite DW	0.5414	0.6391	0.9759	0.6391	0.5414	0.5414	0.6310	0.4909	1.0000
Min LD	4.56	1.38	7.95	1.91	3.40	2.86	13.11	7.96	12.15
Max LD	27.61	8.31	54.65	11.50	20.57	17.32	73.20	25.03	48.00
Average LD (ALD)	16.09	4.84	31.30	6.71	11.99	10.09	43.16	16.50	30.08
DALL = LL + ALD	20.09	5.84	50.30	11.71	32.99	30.09	100.76	59.50	36.08
WITH COUNTERFACTUAL									
Min Composite DW	0.0739	0.0906	0.1021	0.0906	0.0739	0.0739	0.0678	0.1321	0.2145
Max Composite DW	0.4547	0.5525	0.8734	0.5525	0.4547	0.4547	0.4799	0.3924	0.8667
Min $\widehat{LD}$	3.77	1.18	5.72	1.63	2.81	2.37	7.86	6.73	10.30
Max $\widehat{LD}$	23.19	7.18	48.91	9.94	17.28	14.55	55.67	20.01	41.60
Average $\widehat{LD}$ $\left(\widehat{ALD}\right)$	13.48	4.18	27.32	5.79	10.04	8.46	31.76	13.37	25.95
$\widehat{DALL} = LL + \widehat{ALD}$	17.48	5.18	46.32	10.79	31.04	28.46	89.36	56.37	31.95

DW = Disability Weight, LL = Lives Lost, LD = Life lost due to Disability/Injury/Disorder.

[1] Arnould et al. (2003). [2] Composite DW for injuries treated as open-space bombing. [3] Composite DW for injuries treated as closed-space bombing.
[4] Turner et al. (2016) terrorism-related mass shootings. [5] Malik et al. (2009). [6] Table 4.

Table 4 Disability-adjusted lives lost (DALLs) in recent intentional vehicular assaults

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Location	Date	Venue	Vehicle	Deaths (LL)[1]	Injured[1]	Composite DW	LD (6)×(7)	DALLs LD + LL
Berlin	December 2016	Market	Truck	12	56		35.82	47.82
Columbus, OH	November 2016	University	Automobile	0	12		7.67	7.68
Jerusalem	January 2017	Esplanade	Truck	4	15		9.59	13.60
London	June 2017	Bridge	Van	8	48	0.6397	30.70	38.71
London	March 2017	Bridge	Automobile	6	49		31.34	37.35
Nice	July 2016	Promenade	Cargo Truck	86	434		277.63	363.63
Stockholm	April 2017	Street	Truck	5	9		5.75	10.76
MEDIAN				**6**	**48**		**59.93**	**36.71**

[1] Source: Wikipedia

Table 5 Disability-adjusted life years (DALYs) lost to terrorism for individual types of attack

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BOMBINGS[1] (Median Values)						Mass Shooting[4]	Combined Gunshot & Explosion[5]	Recent Vehicular Assaults[6]
	Confined Space	Open Space	Suicide	Vehicle Delivery[2]	Structural Collapse[3]	Structural Fire[3]			
Deaths (Lives Lost)	4	1	19	5	21	20	57.60	43	6
Injuries	51	13	56	56	38	51	116.00	51	48
Disability-Adjusted Lives Lost (DALL)	20.09	5.84	50.30	11.71	32.99	30.09	100.76	59.50	36.71
	$\text{DALY} = \text{DALL} \times Y$ $(Y = \text{Years Lost} = \tfrac{1}{2}Y_{\text{Female}} + \tfrac{1}{2}Y_{\text{Male}})$								
Israel[7] (Mean Victim Age = 24.7) $Y_{\text{Female}} = 59.3$, $Y_{\text{Male}} = 55.3$	1,151	335	2,882	671	1,890	1,724	5,773	3,409	2103
Norway[8] (Mean Victim Age = 19) $Y_{\text{Female}} = 65$, $Y_{\text{Male}} = 61$	1,265	368	3,169	738	2,078	1,896	6,348	3,748	2313
U.S.A.[9] (Mean Victim Age = 39) $Y_{\text{Female}} = 42$, $Y_{\text{Male}} = 37$	793	231	1,987	462	1,303	1,189	3,980	2,350	1405

[1] Arnould et al. (2003). [2] Composite DWs treated as open-space. [3] Composite DWs treated as-closed space. [4] Turner et al. (2016) terrorism-related mass shootings. [5] Malik et al. (2009). [6] Table 4. [7] Amogey et al. (2004). [8] Stene et al. (2006). [9] Mallonee et al. (1996).

Table 6 Annual disability-adjusted life years (DALYs) lost to terrorism

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	GTD Annual Total
	BOMBINGS						Mass Shooting	Combined Gunshot & Explosion	Vehicular Assaults	
	Confined Space	Open Space	Suicide	Vehicle Delivery	Structural Collapse	Structural Fire				
Imputed Deaths* (Lives Lost)	493	493	1,406	493	493	143	3,440	1,290	87	8,338
Imputed Injuries†	1,408	1,408	2,430	1,408	1,408	130	1,203	1,025	366	10,785
Disability-Adjusted Lives Lost (DALL)	937	1,018	2,764	1,018	937	185	3,888	1,621	316	12,682
Victim Profile	$DALY = DALL \times Y$ (Y = Years Lost = $\frac{1}{2}Y_{Female} + \frac{1}{2}Y_{Male}$)									**TOTAL**
Israel[1] (Mean Victim Age = 24.7) $Y_{Female} = 59.3$, $Y_{Male} = 55.3$	53,691	58,303	158,372	58,303	53,689	10,576	222,761	92,904	18,095	**726,695**
Norway[2] (Mean Victim Age = 19) $Y_{Female} = 65$, $Y_{Male} = 61$	59,032	64,103	174,127	64,103	59,030	11,628	244,921	102,146	19,895	**798,984**
U.S.A.[3] (Mean Victim Age = 39) $Y_{Female} = 42$, $Y_{Male} = 37$	37,012	40,192	109,175	40,192	37,011	7,291	153,562	64,044	13,579	**502,056**

* Normalized GTD proportion of deaths for corresponding attack tactic × GTD total deaths.

† Normalized GTD proportion of injuries for corresponding attack tactic × GTD total injuries.

[1] Amogey et al. (2004). [2] Stene et al. (2006). [3] Mallonee et al. (1996).

Table 7 Terrorism and the global burden of disease

Rank	Disease	DALYs[1] (Thousands)
1	Ischaemic heart disease	129,820
2	Lower respiratory infections	115,277
⋮		
260	Animal contact (non-venomous)	929
261	Thyroid cancer	836
262	Dengue	825
263	Vitamin A deficiency	806
266	Non-melanoma skin cancer	798
265	Inguinal or femoral hernia	791
	TERRORISM	**727**
266	Sexually transmitted chlamydial diseases	714
267	Other gynaecological diseases	705
268	Hodgkin's disease	647
269	Trichomoniasis	638
⋮		
289	Gout	114
290	Leprosy	6
291	Yellow Fever	< 0.5

[1] Murray et al. (2012)

Table A1 Comparison of composite disability weights by comorbidity method

	BOMBINGS			Mass Shooting	Combined Gunshot & Explosion	Vehicular Assault	Average Absolute Difference
	Confined Space	Open Space	Suicide				
ADDITIVE Composite DW+ **Using MINIMUM Injury Weights**	0.0895	0.1061	0.1419	0.1130	0.1657	0.2531	0.0090
MULTIPLICATIVE Composite DW* **Using MINIMUM Injury Weights**	0.0865	0.1019	0.1335	0.1081	0.1470	0.2285	
ADDITIVE Composite DW+ **Using MAXIMUM Injury Weights**	0.5414	0.6391	0.9759	0.6310	0.5105	1.0000	0.1809
MULTIPLICATIVE Composite DW* **Using MAXIMUM Injury Weights**	0.4350	0.5022	0.6509	0.4932	0.4042	0.7076	

Injury distribution data are taken from Table 1. Minimum and maximum disability weight data are taken from Table 2.

Table A2 Injury and disorder frequency counterfactuals
[Per 100 people in specified population]

SEQUELA	Counterfactual Frequency $\hat{f}_i$	Population Characteristic or Remarks	Source
Blast Lung	0.00000	Bombs and explosions cause unique patters of injury seldom seen outside combat.	CDC (2016) https://www.cdc.gov/masstrauma/preparedness/primer.pdf
Tympanic Membrane	0.00000		
Extremity	0.04050	Six European Countries	Polinder et al. (2007)
Head and Neck (not face)	0.02510		
Limb Fracture	0.10990		
Lower Limb	0.08160		
Spine	0.01950		
Upper Limb	0.06880		
Abdominopelvic	0.02729	U.S. Age Standardized	Supplement to U.S. Burden of Disease Collaborators (2013)
Burns	0.00768		
Facial	0.09677		
Limb Amputation	0.00562		
Thorax	0.06522		
MDD	0.0090	European Study Onset Past 12 Months	ESEMeD/MHEDEA 2000 Investigators (2004)
PTSD	0.0390		