ACTION ON ARMED VIOLENCE

AOAV

AN ANATOMY OF THE BEIRUT PORT BLAST

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Cover illustration
“The Gesture,” a memorial to the victims of the 4 August explsoion, Beirut Port (Jake Tacchi)

Clarifications or corrections from interested parties are welcome

Research and publication funded by the Government of Norway, Ministry of Foreign Affairs

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Introduction

At around 18:08 on 4 August 2020, an enormous explosion occurred at the Port of Beirut in Lebanon. The blast, among the largest non-nuclear explosions in history, tore through the densely populated city which is home to approximately half of Lebanon's population.[1] More than 200 people were killed and over 6,000 were injured as the blast destroyed residential areas, hospitals and schools - irreparably damaging the fabric of the city and changing the lives of its citizens.

The exact causes of the explosion remain unclear. Attempts to comprehensively investigate the blast have been consistently obstructed by a Lebanese political and judicial class highly resistant to the establishment of truth, accountability and retribution. What is clear, however, is that a significant number of key ministries and individuals within the Lebanese state were aware of the large ammonium nitrate store at the now-devastated port, and the dangers it posed to human life.[2]

Whilst supporting and advocating for greater research into accountability and legal redress surrounding the explosion, these factors are beyond the scope of this report and are better left to the organisations already carrying out excellent work in this field.[3]

Instead, Action on Armed Violence's (AOAV) 'An Anatomy of the Beirut Port Blast' sets out to highlight the varied immediate and longer-term impacts brought about by the explosion. This, in turn, will help to support greater understanding of the wide-ranging and interconnected civilian and humanitarian consequences that arise from a blast of this magnitude in populated areas.

Methodology

AOAV is guided by the United Nations Institute for Disarmament Research's (UNIDIR) 'Menu of Indicators to Measure the Reverberating Effects on Civilians from the use of Explosive Weapons in Populated Areas' (hereafter EWIPA indicators).[4] These indicators - constantly being developed and improved by UNIDIR - offer a framework for researchers to better measure and quantify the humanitarian consequences of explosive violence.

From the start, however, it is necessary to highlight the inherent difficulty in the term 'explosive weapon'. The Beirut Port blast is not a typical AOAV case study. For example, it was not recorded in AOAV's Explosive Violence Monitor (EVM) because it did not involve what is *traditionally* referred to as an explosive weapon (either manufactured or improvised).[5]

Faced with a distinct lack of official evidence and enquiry, the Beirut Explosion continues to occupy the space between industrial accident and explosive weapon. It seems very unlikely that large quantities of ammonium nitrate were stored with the express purpose of inflicting harm to the citizens of Beirut. Nevertheless, gross negligence from a variety of key actors allowed a potential weapon to be created in the city and hugely increased the possibility of accidental detonation. This merits an investigation into the blast alone.

Figure 1 **Four SDGs framing the UNIDIR indicators.**

Lebanon: the EU's response to the tragic explosions in Beirut, EU Civil Protection and Humanitarian Aid (CC BY-NC-ND 2.0).

Regardless of the semantic difficulties in the term 'weapon', the Beirut Port blast offers a strong case study to better understand the wide-spread and multifaceted impacts that emerge as a result of large explosions in populated areas. This report chooses to treat the Beirut blast as an explosive weapon and, as a result, the EWIPA indicators remain one of the most useful frameworks for analysis.

To allow greater analytical flexibility and to combat the methodological problems of solely attributing consequences to explosive violence in the midst of Lebanon's economic collapse and the Covid-19 pandemic, AOAV has chosen not to rigidly structure this report through individual EWIPA indicators.

Instead, AOAV sticks firmly to the Sustainable Development Goals (SDGs) framing the EWIPA indicators, whilst utilising sole indicators in a more flexible manner.

Using this framework, AOAV conducted extensive interviews in Beirut from August-October 2021 with medical personnel, victims, academics, humanitarian workers, teachers and legal professionals. These interviews were combined with desk-based research to better understand how a blast of this magnitude impacts on a range of factors concerning development, health, education and livelihoods both immediately and in the long-term.

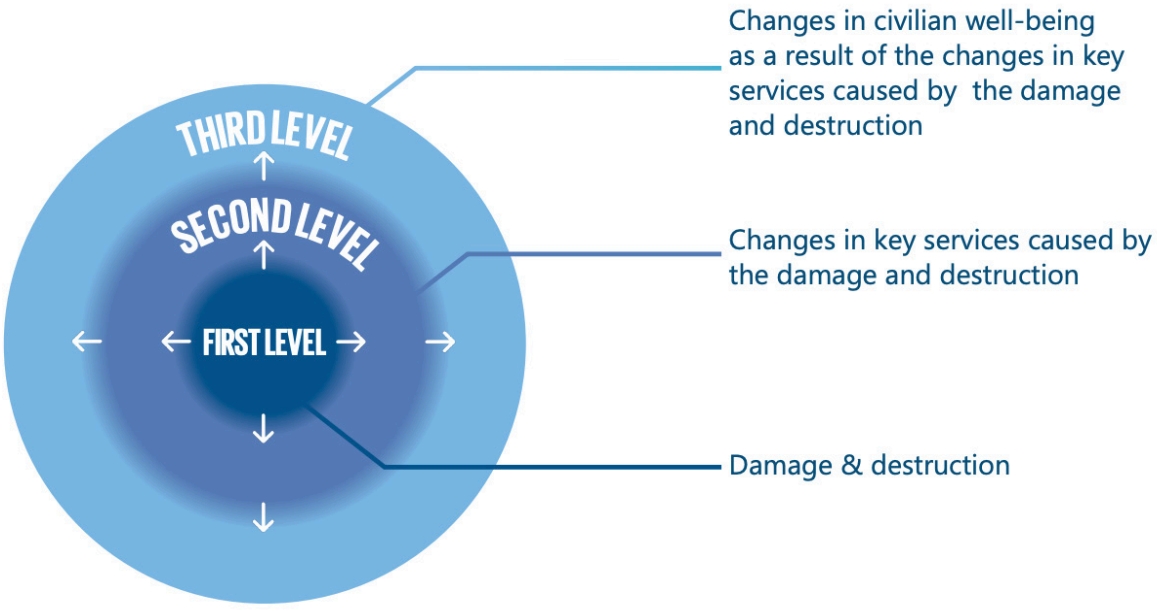


Figure 2 **UNIDIR - Impact levels from instances of explosive weapon use.**[6]

FOCUS AREA	LEVEL OF EFFECT	INDICATORS	LEVEL OF CERTAINTY (ANTICIPATED)
16 PEACE, JUSTICE AND STRONG INSTITUTIONS	**Primary and/or secondary effects:** Direct civilian deaths and injuries	Number of direct civilian deaths and injuries from explosive weapons , disaggregated by gender and age	Demonstrable causality
	Reverberating effects: Indirect civilian deaths and injuries	Number of indirect civilian deaths and injuries from explosive weapons, disaggregated by gender and age	Merits deeper EWIPA-related research
11 SUSTAINABLE CITIES AND COMMUNITIES	**First level:** Damage and destruction	Number or proportion of housing or shelter damaged or destroyed by explosive weapons	Demonstrable causality
		Number or proportion of cultural property damaged or destroyed by explosive weapons	
		Number or proportion of service plants and installations damaged or destroyed by explosive weapons	
		Proportion of transport network damaged or destroyed by explosive weapons	
	Second level: Changes in key services caused by the damage and destruction	Number or proportion of key services disrupted, including water, wastewater and solid waste management, electricity, transport networks, and communications	
	Third level: Changes in civilian well-being as a result of the changes in key services caused by the damage and destruction	Number or proportion of population displaced, disaggregated by gender and age	Merits deeper EWIPA-related research
		Number of deaths, missing persons and persons affected by explosive weapons per 100,000 population, disaggregated by gender and age	
3 GOOD HEALTH AND WELL-BEING	**First level:** Damage and destruction	Number or proportion of health facilities damaged or destroyed by explosive weapons	Demonstrable causality
		Number of health workers killed or injured by explosive weapons, disaggregated by gender	
		Shortages in essential medical supplies	
		Number or proportion of ambulances destroyed (locally)	
	Second level: Changes in key services caused by the damage and destruction	Number or proportion of health facilities with service disruptions	
		Health worker density and distribution per 10,000 population, compared with pre-conflict	Reasonable association
		Difference in proportion of births attended by skilled health personnel, compared with pre-conflict	
		Difference in proportion of the population with access to affordable medicines and vaccines, compared with pre-conflict	
	Third level: Changes in civilian well-being as a result of the changes in key services caused by the damage and destruction	Difference in maternal, neonatal and under-five mortality, compared with pre-conflict	Merits deeper EWIPA-related research
		Difference in mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease, compared with pre-conflict	
		Difference in reported cases of and number of deaths from preventable diseases such as cholera, measles or polio or changes in the life expectancy of HIV-positive patients, compared with pre-conflict	
4 QUALITY EDUCATION	**First level:** Damage and destruction	Number or proportion of education facilities damaged or destroyed by explosive weapons	Demonstrable causality
		Number or proportion of educators killed or injured by explosive weapons, disaggregated by gender	
	Second level: Changes in key services caused by the damage and destruction	Number or proportion of education facilities with service disruptions, including Internet	
		Number of schooling days lost	Reasonable association
		Number or proportion of children without access to schooling, disaggregated by gender and age	
	Third level: Changes in civilian well-being as a result of the changes in key services caused by the damage and destruction	Number, proportion or rate of students who drop out of schooling, disaggregated by gender	Merits deeper EWIPA-related research
		Proportion of students achieving at least a minimum proficiency level in reading and mathematics, disaggregated by gender	
		Proportion of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, disaggregated by gender	

Figure 3 **UNIDIR - Summary of indicators to measure the impact chain of explosive weapon use, per focus area.**[7]

Background

Explosive Violence in Lebanon

Between 2011 and 2020, AOAV's EVM has recorded 2,620 casualties from explosives in Lebanon - the 13th worst-affected country from explosive violence in this decade.[8] When compared with other badly-affected countries, Lebanon saw a particularly large percentage of civilian casualties, alongside a high number of average civilian casualties per explosive incident. Over this ten year period, 91% of all casualties from explosive violence in Lebanon were civilians - the highest percentage amongst the 15 worst-affected countries; whilst its average of 17 civilian casualties per explosive incident was only surpassed by Nigeria. What is more, 99% of all civilian casualties recorded in Lebanon over the past decade occurred in populated areas.

EVM figures for Lebanon do not include the August 2020 Port Explosion due to the nature of detonation and the fact that the large ammonium nitrate stores were not considered explosive weapons in a conventional sense. However, if the Port Explosion were to be included, this single event would more than triple Lebanon's casualty figures for the past decade, making it the country 7th worst-affected by explosive violence. Such was the size, scope and devastation of the blast.

Over the past decade, 85% of all civilian casualties from explosive violence in Lebanon were the result of IEDs, with several large-scale attacks accounting for the majority of casualties recorded. The most devastating of which was a twin car bombing targeting two mosques in the city of Tripoli in August 2013.[9] The attack killed 47 and injured 500 and was the eighth-worst explosive event recorded by AOAV between 2011 and 2020.

The EVM has only recorded global explosive incidents since the beginning of 2011, but Lebanon's history is littered with high levels of explosive violence, particularly during the 2006 Israel-Hezbollah War and the country's 15-year civil war. AOAV's report 'When the Bombs Fall Silent', explores many of the reverberating consequences of the 2006 war - defined by intense Israeli bombing campaigns - on health systems, the economy, the environment and society in Lebanon.[10]

Neighbouring States

Lebanon's geography cannot be ignored. The country shares a long land border with Syria - the state worst-affected by explosive violence between 2011 and 2020. In this time period, AOAV recorded 7,455 explosive incidents in Syria, resulting in 77,534 civilian casualties.[11] This has created significant instability within Lebanon and a large proportion of explosive violence perpetrated in the country is attributed to groups active in the Syrian Civil War, such as the al-Nusra Front and the Farouq Brigades.

In the South, we find Israel and the Occupied Palestinian Territories (OPT) - historically areas of intense explosive violence. The Gaza Strip has borne the brunt of this, with AOAV recording 5,700 casualties in Gaza between 2011-2020 - of which 90% were civilians.[12] In Lebanon, constant and unabating tensions with Israel raise the risk of further explosive violence, whilst unexploded ordnance (UXO) - often the remnants of internationally-banned cluster munitions fired during the 2006 war - continue to maim and kill civilians.

Conflict, instability and explosive violence at Lebanon's borders have also played a part in the country's extremely large refugee population. Whilst rarely the sole reason, explosive violence is a key factor driving displacement globally.[13] According to UNHCR, there were 851,717 registered Syrian refugees in Lebanon in July 2021 - although government estimates are closer to 1.5 million due to the large numbers of unregistered individuals.[14] This number has been falling slowly since 2015, but Lebanon still hosts the highest number of refugees per capita in the world.[15] This brought with it unique humanitarian concerns following the Beirut Port explosion.

Ammonium Nitrate Disasters

Ammonium nitrate was first synthesised in 1659.[16] Traditionally, its primary application has been as a high-nitrogen fertiliser, spread over farms throughout the world to improve agricultural yields. However, due to the compound's explosive qualities, it also has commercial uses in mining, where its ability to

> ***Every explosive store should be sited and managed on the presumption that it will explode.***
>
> Roger Davies MBE, Explosives Expert.[17]

produce large amounts of energy in a long pressure wave makes it highly effective in shifting substantial quantities of rock and other materials.[18]

Due to ammonium nitrate's commercial uses and relatively low cost, stores of the compound are rife throughout the world. This typically poses very little risk. When kept correctly, ammonium nitrate is overwhelmingly safe. More often than not it is stored as small, circular beads (or prills) making it near impossible for a detonation wave to propagate through the material. Despite this, if ammonium nitrate is stored without proper safety considerations, risks become more prevalent. Prolonged exposure to heat or moisture causes small prills to coalesce, forming large, dense blocks which a shock or detonation wave can pass through more easily.[19]

Although rare, when ammonium nitrate is improperly used or stored, it has the potential to cause significant destruction and loss of life. Since 1916, ammonium nitrate has been responsible for at least 30 disasters - some accidental and some intentional.[20] Infamous examples include the Texas City disaster of 1947, where fires aboard the SS Grandcamp caused the ship's cargo of 2,300 tonnes of ammonium nitrate to detonate.[21] The explosion and subsequent fires killed at least 581. More recently, a series of explosions involving illegal stores of ammonium nitrate at the Port of Tianjin, China, killed 173 people in 2015.[22]

It is clear that few measures had been taken to ensure the safety of the huge store of ammonium nitrate kept in 'Hangar 12' at the Port of Beirut. Images obtained by *Forensic Architecture* show sacks of the compound, sometimes ripped and spilling over, haphazardly stacked throughout the poorly-ventilated warehouse alongside a range of other combustible materials.[23] Whilst the conditions seen in Hangar 12 did not guarantee a disaster would occur, it did increase the risks enormously.

Ammonium Nitrate and Explosive Weapons

Alongside ammonium nitrate's uses in agriculture and mining, it has been a component of conventional explosive weaponry since World War I, when it was first mixed with TNT to make cheaper bombs.[24] Since then, the compound has been used by armies, terrorist groups and lone actors to inflict damage on armed actors and civilians. Typically this has been in the form of 'ANFO' (ammonium nitrate mixed with fuel oil) - a way of 'treating' ammonium nitrate to make it more effective and damaging as an explosive. One of the most infamous cases of this was the Oklahoma City bombing of 1995 where Timothy McVeigh employed an ammonium-nitrate-based explosive to kill 168 people at the Alfred P. Murrah Federal Building in Oklahoma.[25]

More recently, ammonium nitrate has been a well documented component of 'barrel bombs'.[26] These weapons, made by filling oil drums with explosives and dropping them from high altitudes, have been particularly prolific in the Syrian Civil War. The Syrian Network for Human Rights (SNHR) have estimated that since 2011, the Syrian Regime dropped close to 82,000 barrel bombs, killing 11,087 civilians (1,821 of whom were children).[27] Due to their high explosive content and wild inaccuracy, barrel bombs have brought about high civilian casualties and their indiscriminate use in populated areas should, AOAV and other humanitarian bodies maintain, constitute a war crime.

20th Anniversary - Oklahoma City Bombing - 150419, usacetulsa (CC BY 2.0).

Beirut Port Blast - 4 August 2020

In 2013, the Rhosus, a cargo ship flying the Moldovan flag left the Black Sea port of Batumi, Georgia destined for Mozambique and carrying 2,750 tonnes of ammonium nitrate.[28] The ship, barely seaworthy and with shadowy ownership, never reached its destination.[29]

Having suffered technical problems, the ship docked at Beirut's port on 21 November 2013, where port officials forbade it from sailing on.[30] Due to legal troubles and lack of payment, the vessel and its cargo were impounded by Lebanese authorities. As the status of the Rhosus and her crew remained unclear, port authorities transferred the ammonium nitrate cargo to Hangar 12 in early 2014. There it remained - improperly stored - for six years, despite numerous complaints from senior customs officials.[31]

It was, effectively, a ticking time bomb that was just waiting for the moment of disaster.

That time came at around 17:45 on 4 August 2020, when a fire broke out in Hangar 12. Shortly afterwards a team from the Beirut Fire Service was dispatched to fight the fire. At around 18:07 an initial explosion occurred - likely triggered by fireworks stored in the warehouse - sending a large smoke plume dotted with bright flashes.[32] 30 seconds later, a second, much larger explosion occurred releasing a supersonic blast wave which propagated through the city.[33]

The immediate destruction was immense. The blast, which could be felt in Cyprus, created a 140m wide crater at the port, destroyed large swathes of the city, killed hundreds and injured thousands.[34]

Although many key officials had knowledge of the ammonium nitrate stored in Hangar 12, no warning was given to evacuate parts of the city close to the port. Members of the Beirut Fire Department were sent to the scene, despite the huge risks the contents of the hangar posed.[35]

A destroyed warehouse at Beirut's port, Jake Tacchi (2021).

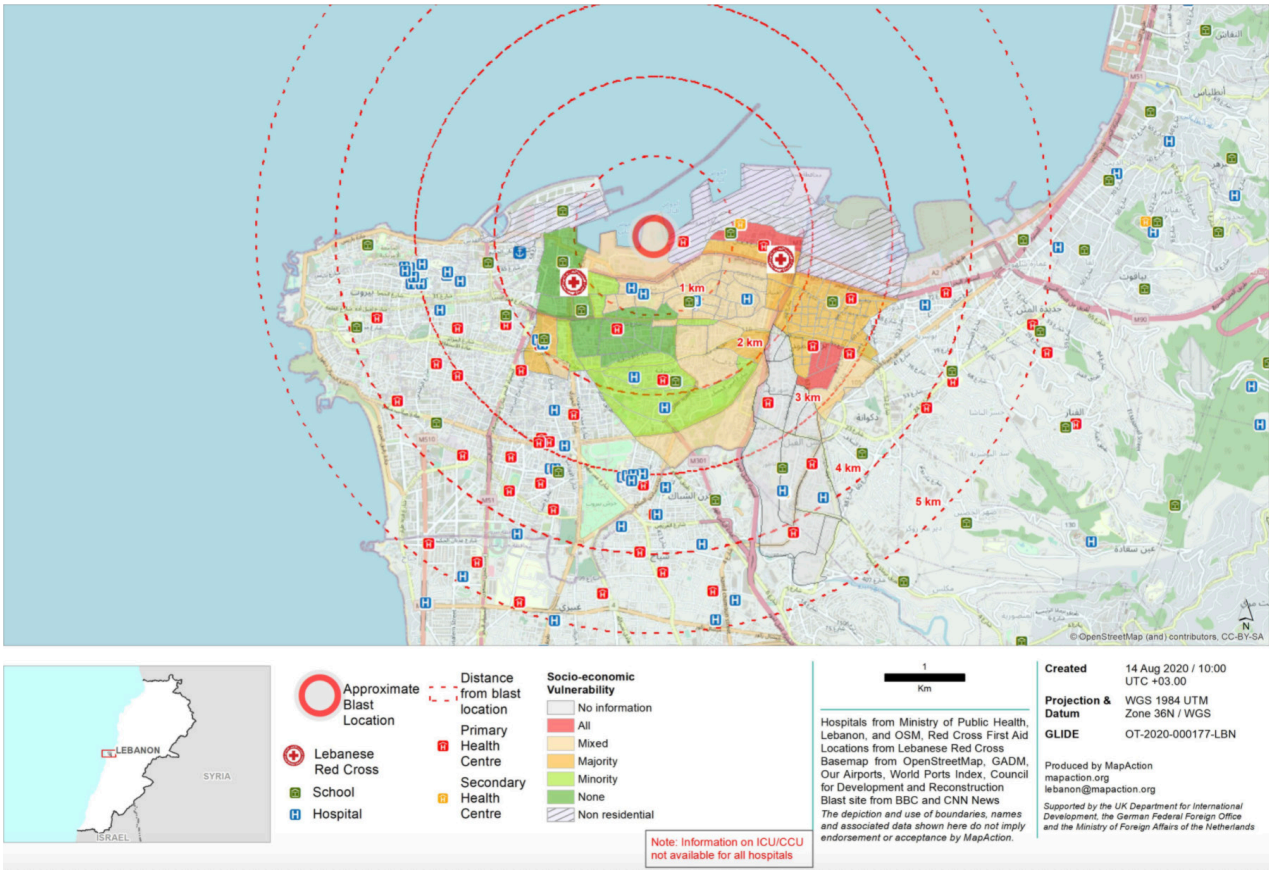
If a warning had been given as soon as smoke was observed, those closest to the port would have had more than 25 minutes to evacuate their homes to much safer distances. Instead, unaware of the dangers, curiosity led many residents - especially those in apartments facing the port - to their windows or out onto their balconies to investigate the growing smoke plume. As a result, when the second explosion took place, many people were in the most dangerous areas of their homes. This explains - in part - the high number of secondary injuries sustained in the blast.[36]

Alongside death and injury, the blast caused untold damage to the fabric of Beirut, destroying homes, key services, medical infrastructure and education facilities. The economic impacts were severe. Beirut's port had served as the country's main maritime entry point for 80% of imported goods and channelled more than two-thirds of Lebanon's total external trade.[37] The enormous silos adjacent to the blast epicentre also contained 85% of the country's grain stores and were completely destroyed.[38]

It was estimated that 70,000 people lost their jobs as a result of the blast. The explosion caused a total of $3bn in insured losses, and over $15bn in economic losses.[39] This occurred during a difficult Covid-19 response and in the midst of an overwhelming economic collapse which the World Bank has cited among the worst three crises in the past 150 years.[40]

A cocktail of negligence and mismanagement - stemming from government corruption - turned a large store of ammonium nitrate into a devastating explosive weapon with unimaginable consequences for Beirut, its citizens and Lebanon as a whole. In the coming sections, AOAV will address some of these interweaving consequences in order to quantify and examine the disastrous impacts which occur when large explosions take place in populated areas.

> ***The main reason our daughter died is that endemic corruption, greed and cheap politics allowed for the deadliest bomb in modern history to be stored 750m from our home.***
>
> Victim of the Beirut Port blast.[41]



Beirut explosion site with infrastructure sites and vulnerability, Map Action.[42]

SDG 16 - Peace, Justice and Strong Institutions

> ***The blast and heat effects of explosive weapons can kill and injure civilians. The falling and flying debris and other materials from urban areas damaged by explosive weapons can also kill and injure. These are part of the primary and secondary effects of explosive weapons use in populated areas... Death and injury have far-reaching consequences for families and communities, ranging from economic to mental health impacts, and constitute a third-level impact of explosive weapons use.***
>
> UNIDIR.[43]

Death and Physical Injury

At least 218 people were killed as a direct result of the Beirut Port Explosion and around 7,000 were injured - at least 150 of whom acquired a physical disability.[44] Today, those badly affected by the blast continue to die from their injuries. On 28 September 2021, Ibrahim Harb - a 35-year-old accountant - became the most recent victim of the port blast, having survived for 14 months with the critical injuries he had endured.[45]

Three children between the ages of 2 and 15 lost their lives in the explosion and around 1,000 were injured.[46] Difficulties in accurately recording disaggregated casualty data for an explosion this size, makes ascertaining gender breakdowns amongst victims difficult. However, Care International's rapid gender analysis suggests that men accounted for around two-thirds of all identifiable deaths (recorded at the end of August 2020).[47]

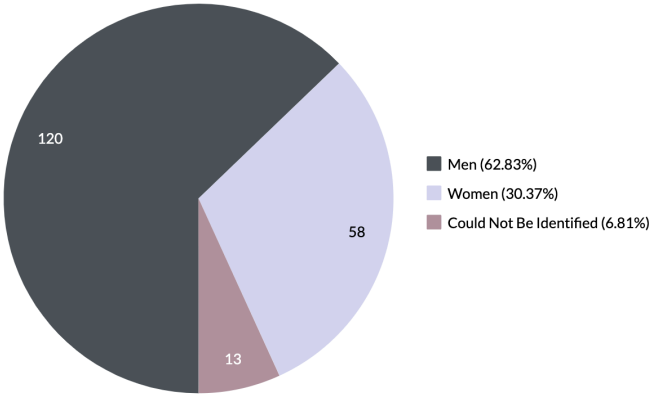


Figure 4 **Care International - Gender breakdown of blast victims.**[48]

The majority of injuries recorded in hospitals following the explosion were secondary blast injuries caused by debris (typically glass) displaced by the blast's subsequent detonation wind.[49] Tertiary injuries - the result of structural collapse and individuals being thrown by the blast - were also commonplace.[50] Due to the size of the explosion, most primary injury (caused by blast overpressure, typically affecting those closest to the epicentre) was fatal.[51]

However, not all injuries were sustained in the immediate moments after the blast. Medics and volunteer groups have highlighted that many injuries occured as part of the enormous cleanup operation.[52] UNDP estimated that around 20,000 tonnes of glass waste was produced from the blast, the clearing of which often caused cuts to volunteers and residents lacking the proper safety equipment.[53]

Mental Health

The impact of the blast on mental health was devastating. Embrace, a leading organisation providing mental health services and awareness in Lebanon, saw their emotional support and suicide prevention hotline, the Embrace Lifeline, receive more calls between August and November 2020, than in the entirety of 2019.[54]

Although Lebanon's economic crisis and the Covid-19 pandemic are likely contributors to a worsening mental health situation in the country, it

cannot be denied that the destruction and shock brought about by the 4 August explosion had significant effects on the mental health of many in Beirut and beyond.

Embrace also carried out a survey of 903 men and women, aged between 18 and 65, shortly after the blast, and found that 83% of respondents reported feeling sad almost every day, and 84% felt extra sensitive to loud noises.[55] Similarly, a World Bank survey highlighted that mental health services were amongst Beirut residents' most pressing needs, cutting across both geographic location and wealth category.[56]

Children were no different. UNICEF estimated that 630,000 children required psychosocial support following the explosion, whilst a World Vision survey showed that 90.5% of children interviewed were suffering from 'psychosocial distress'.[57] The effect this has on schooling will be discussed later in this report.

Surveys carried out in the months following the blast reflected a clear improvement in both the scope and intensity of mental health conditions in Beirut.[58] In the weeks following a traumatic event, it is often the case that large numbers of people will suffer acute stress disorders, but the majority will not go on to develop the more severe psychological condition, post-traumatic stress disorder (PTSD).[59] However, around 10% of those suffering from acute stress disorder will go on to suffer from PTSD.[60]

One area which has been less well documented is how traumatic events can exacerbate and reintroduce past trauma - a more serious concern in areas, like Lebanon, which have faced explosive violence in the past. Many older Lebanese citizens, who lived through the country's devastating 15-year civil war, reported being re-traumatized by the explosion'.[61] AOAV also interviewed a medical professional who admitted that, following the explosion, he had regular nightmares related to a traumatic event he had witnessed as a child during the civil war, 30 years previously.

It has also been cited that the complete 'unexpectedness' of the explosion, which did not occur during a war, conflict or insurgency, made the psychological impacts far greater:

> ***We were sitting in our home, they killed us in our homes, we didn't do anything to deserve this. We weren't expecting it, there was no war. War conditions would have been easier for us than this.***
>
> Victim of the Beirut Port blast.[62]

As is always the case, psychological impacts differ vastly from person to person. It is clear that those who were badly injured or lost close family members are the most likely to suffer serious and long-term psychological turmoil. Nevertheless, more research is required to better understand - and therefore treat - the psychological conditions emerging from explosive violence, especially as a result of large-scale events.

Refugees

It was estimated that close to a quarter of all those killed in the blast were Syrian.[63] However, it is highly likely that this figure (and therefore the total death toll) was much higher due to the large proportion of unregistered Syrians in Lebanon who would not have been included in official casualty figures. Due to the large refugee populations living in badly-affected districts close to the port - such as Karantina - UNHCR also estimated that 14,600 refugees lived within 2.5km of the blast, whilst 125,600 lived within 5km.[64]

Although the multifaceted effects of the Beirut explosion have had untold impacts on the vast majority of the city's population, the specific case of refugees and asylum seekers must be highlighted. Displaced people - who in many cases have faced disasters and explosive violence in the past - are particularly susceptible to the negative effects of subsequent catastrophes which can amplify existing difficulties surrounding access to healthcare, education, legal support and housing. Some have also highlighted that the psychological strain on Lebanon's refugee population has been particularly severe, as the explosion brought increased "flashbacks, nightmares and anxiety" to many already suffering with PTSD from the conflicts they have fled.[65]

> ***The blast was even worse than what we experienced in Syria. At least, back there, we knew we might not live to see another day. But we never expected this here.***
>
> Fatima Abumaghara, 35, whose husband died in the port explosion.[66]

Accountability

International law states that the primary responsibility for the protection of civilians lies with the government itself, but the Lebanese state has made little effort to establish truth, justice and accountability surrounding the events of 4 August.

Following the port explosion, the Lebanese government launched three separate investigations: an administrative inquiry, a military investigation and a judicial investigation.[67] These inquiries are consistently obstructed and delayed by a Lebanese political and judicial system highly resistant to establishing truth and accountability. In addition, both the US and French governments conducted separate investigations at the request of the Lebanese state.[68] None of the findings are publicly available and 'official' research into the blast has been clouded in secrecy, with the epicentre of the explosion blocked off to independent researchers by the Lebanese Armed Forces.[69]

Victim's families protest outside the Lebanese Ministry of Justice, Beirut, 29 Sep 2021, Jake Tacchi (2021).

It is clear that a large number of high-ranking officials had at least some knowledge of the ammonium nitrate stored in Hangar 12 and the dangers it posed. It has even been reported that a January 2020 investigation, highlighting the chemical's ability to "destroy the capital," had been shared with then Prime Minister Hassan Diab and President Michel Aoun.[70] Parliamentary immunity and a wider culture of impunity for political figures in Lebanon has continued to stall any investigation which looks to bring accountability to those culpable.

Following destructive and traumatic explosive events like the Beirut Port explosion, establishing truth and delivering justice to those accountable is a key factor in providing closure to victims. Without proper accountability, victims are denied the opportunity to make sense of a traumatic event.[71] An independent, transparent fact-finding mission and inquiry into the causes and culprits of the 4 August explosion are essential in reducing the psychological strain on victims and ensuring that such events do not occur again.

> ***Lebanese authorities have spent the past year shamelessly obstructing victims' quest for truth and justice.***
>
> Amnesty International.[72]

SDG 11 - Sustainable Citites and Communities

> ***Widespread destruction of residential buildings and shelters by explosive weapons deprives people of safe, adequate, affordable and available housing. Damage and destruction of cultural property and civic spaces severely affects the identity of cities and communities. Explosive weapons can damage public services and transport networks. Damage or destruction of electricity or water installations has far-reaching effects on the economy and living standards and will spark many downstream effects on access to food, water, public health and sanitation, health care, and communications, as well as damage to the environment. Damage and destruction of water plants, wastewater treatment plants, and solid waste management infrastructure reduces living standards and engenders health risks.***
>
> UNIDIR.[73]

Housing

Estimates vary, but it is thought that the explosion caused heavy damage to at least 50,000 residential homes in Beirut.[74] OCHA have also estimated that 9,200 buildings were damaged within a 3km radius of the port, affecting a total of 219,000 people.[75]

Alongside the obvious psychological impact of one's home being destroyed, many were left homeless or were forced to live in unsafe conditions for the months following the explosion. Although repairs took place, their speed was typically dependent on the severity of damage or the homeowners' ability to pay. As a result, many homes in poorer areas remained structurally unsound through a cold and wet winter.[76]

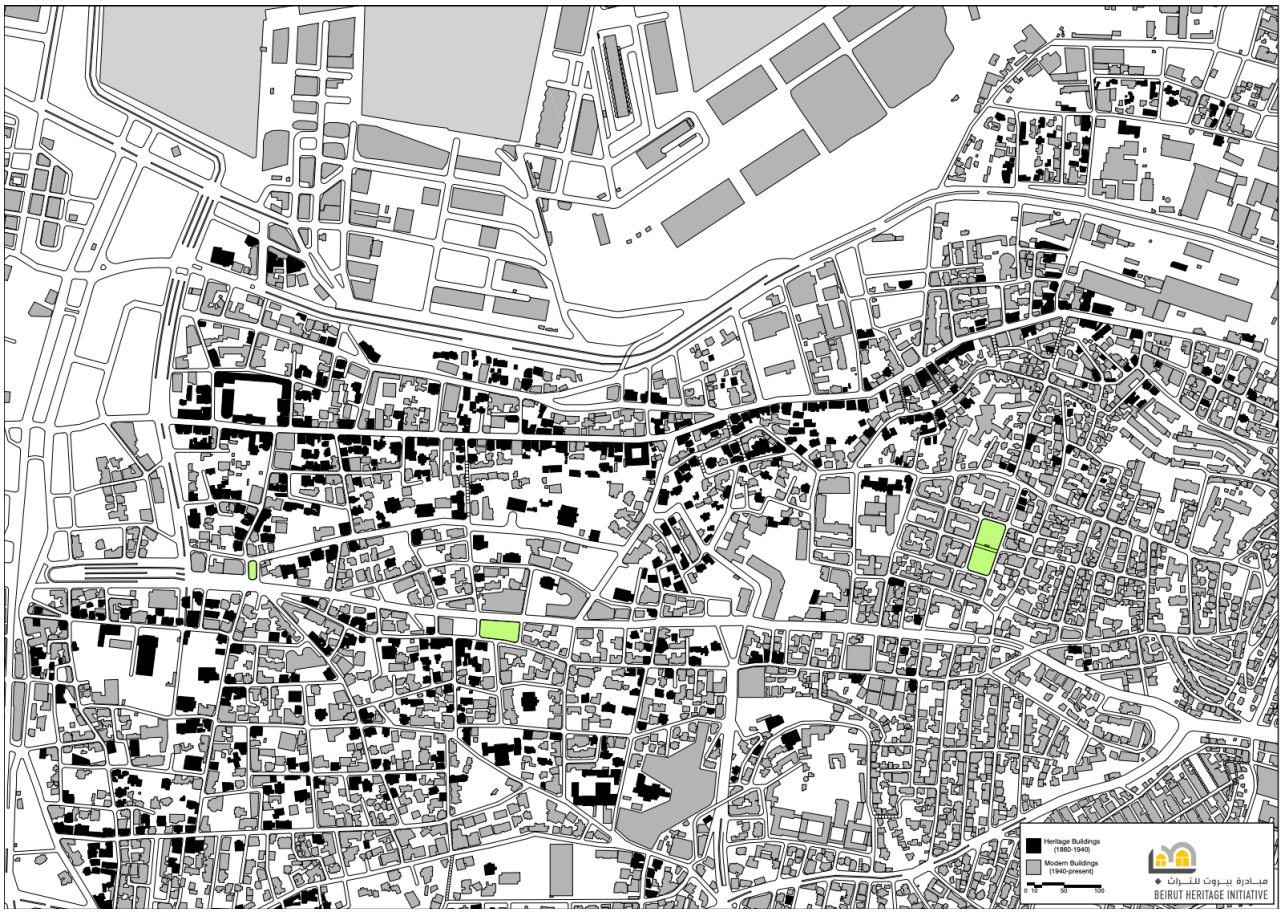
Cultural Property

Many of the neighbourhoods worst hit by the explosion, such as Gemmayze, Mar Mikhael and Ashrafiah, had the highest concentrations of historic structures in Beirut.[77] Buildings closest to the port were often some of the oldest and most culturally significant in the city - their range of architectural styles reflecting the history of Beirut.

In the weeks following the blast, the Director-General of Antiquities at the Ministry of Culture in Lebanon claimed that some 640 historic buildings had been damaged by the blast, of which 60 were at risk of total collapse.[78]

Although great efforts are being made to restore culturally significant buildings - typically without government support or involvement - the difficulties and extra costs associated with restoring buildings using suitable materials and techniques (especially given Lebanon's economic crisis), means that some of Beirut's most significant architectural artefacts may be lost forever.[79]

> ***Within mere seconds more material damage was created than a decade of civil war had seen.***
>
> Beirut Heritage Initiative.[80]



Map showing the location of heritage buildings (1860-1940) in residential areas close to Beirut Port, reproduced with permission from Beirut Heritage Initiative.

Key Services

The port explosion harmed an already faltering Lebanese electricity sector. Preliminary assessments highlighted damages which impacted on transmission and distribution - through the destruction of substations and distribution lines.[81] The headquarters of the state-owned utility company, Electricité du Liban, was also completely destroyed by the blast. Whilst there was no significant impairment to Beirut's main water network, water connections to buildings were often damaged, leaving residents without a clean water supply for weeks.[82]

Damage was much more common for internal networks than public utility networks. UNDP estimated that whilst only 3.5% of electricity systems and 0.3% of water supply systems were damaged in the 'Red Zone', the figure was 12.5% and 7.9% respectively for internal networks.[83]

Damage and disruption to utility supply networks was relatively limited given the magnitude of the blast and the fact it occurred in a densely populated city centre. This, however, is partly the result of ineffective state services - particularly electricity - which pushed residents to adopt individual or community-based solutions (such as generators). This may also explain the higher rates of damage to internal networks. In other cities, an explosion of this size would likely upset water and electricity supplies far more significantly.

'The Blue House', a Beirut heritage building still undergoing repairs in October 2021, Jake Tacchi (2021).

The damaged minaret of Khaled Ibn Al Walid Mosque in Karantina, Beirut, Jake Tacchi (2021).

As for waste services, the main recycling and sorting facility in Karantina was totally destroyed in the blast, whilst the solid waste composting facility in Bourj Hammoud was partially damaged.[84] This significantly impacted the city's ability to deal with waste disposal in the coming months. The subsequent strain on these services was increased further by the huge quantities of waste produced in the explosion, particularly in the form of construction and demolition waste (CDW) from destroyed buildings.

If CDW is not properly disposed of it creates a range of environmental and health concerns in populated areas. For example, Dr. Nadim Farajalla, the Director of the Climate Change and Environment Program at the Issam Fares Institute for Public Policy and International Affairs, told AOAV that piles of rubble at the port were not properly disposed of or even sealed from runoff.[85] As a result, when the autumn rains arrived, large amounts of runoff from potentially-unsafe building waste flowed into the sea. The substantial quantities of rubble that still line the streets in many areas of Beirut also pose potential long-term health concerns, a fact that will be discussed further in the next section.

The headquarters of Electricité du Liban, destroyed in the 4 August explosion, Jake Tacchi (2021).

SDG 3 - Good Health and Well-Being

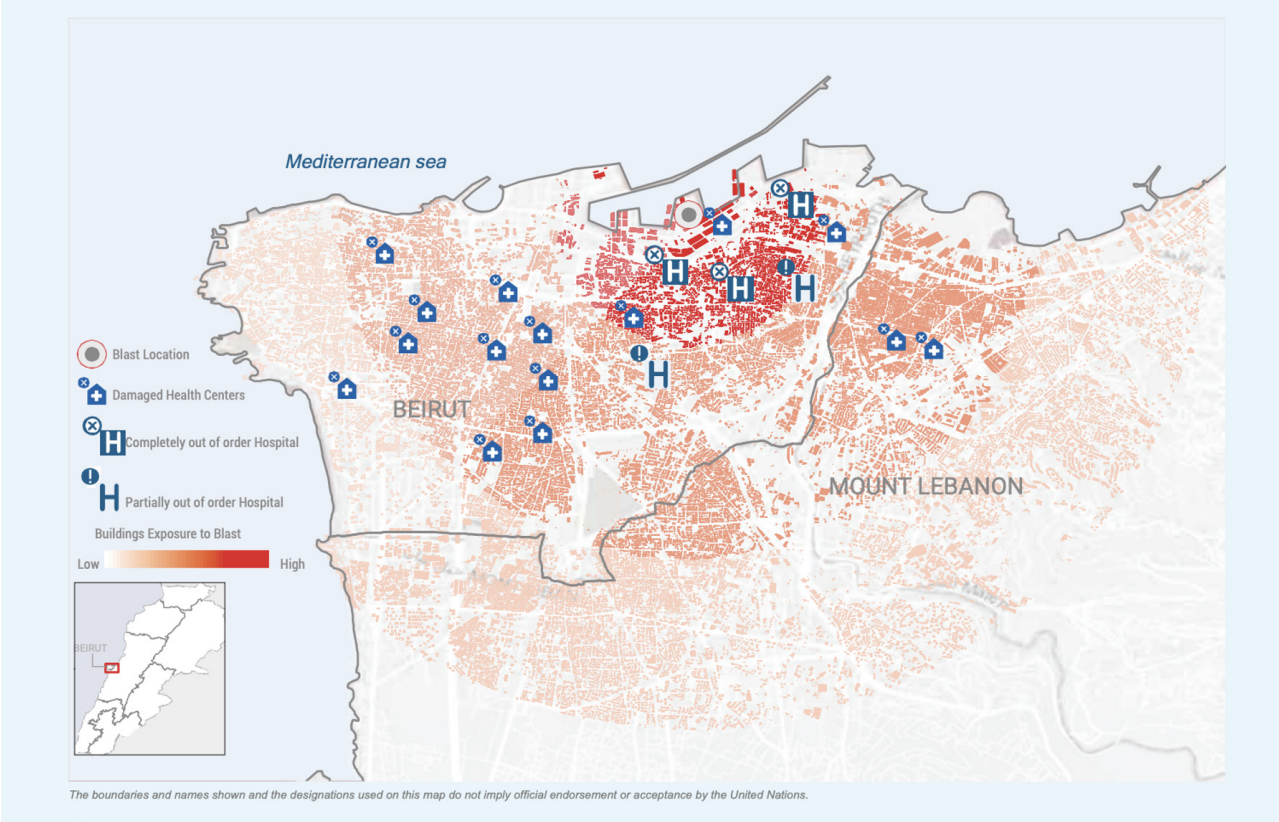
> ***Explosive weapons undermine safe access to health care by destroying health care infrastructure such as hospitals, clinics and health care transport, hindering the quality of care.***
>
> UNIDIR.[86]

Health Facilities and Staff

The Beirut explosion damaged nine of the capital's hospitals, incalculably impeding emergency medical response to the event and leaving a lasting scar on the capital's health sector.[87] Three of the city's major hospitals - St. George's, Wardieh and Karantina - were rendered completely nonfunctional by the explosion, resulting in the loss of around 500 beds.[88]

Large explosive events require a well-organised and well-prepared emergency medical response - something that is not possible when health facilities are destroyed and health personnel are killed and injured. Dr. Alexandre Nehme, the Chief Medical Officer of St. George's Hospital, described how the destruction caused by the blast completely hindered the hospital's ability to deal with the wide-spread emergency situation.[89]

Victims describe scenes of complete disorder on the streets and in hospitals following the explosion. Ambulances were often unable to traverse debris-ridden roads, again affecting the ability of badly injured individuals to receive life-saving medical treatment.[90] A victim of the blast, whose daughter died from injuries sustained, described how the complete destruction of hospitals, and lack of information about where to find medical care, impeded his ability to find his daughter emergency support.[91]



Beirut, Lebanon: Buildings Exposure to the Explosions with Damaged Hospitals and Health Facilities (as of 12 August 2020), UN OCHA.[92]

> ***The day of the explosion was catastrophic for all the nurses, doctors, children, babies and the entire hospital.***
>
> Paediatric Nurse, Karantina Hospital.[93]

It is likely that the death toll from the 4 August explosion was increased significantly by the extensive disruption to emergency medical services.

Four nurses were killed and more than 100 were injured at St. George's Hospital alone.[94] Furthermore, countless medical staff were unable to work for weeks following the blast due to the injuries they sustained, putting further strain on desperate medical services. Whilst often overlooked, the psychological impact explosive events have on health personnel is also an area of significant concern. Many hospital staff saw their colleagues killed and their workplace completely destroyed in mere seconds. This undoubtedly has a deep impact on individuals and AOAV found examples of hospital staff who were forced to take months off work as a result of PTSD.

Beyond hospitals, the explosion affected a range of facilities and services which make up the complex and interlinking system of healthcare. For example, the Lebanese Order of Physicians estimated that over 2,000 doctors' offices and clinics were affected by the explosion, whilst Lebanon's Central Drug Warehouse was also damaged in the blast.[95] This facility stored vaccines, cancer drugs, HIV and tuberculosis medication, amongst other key medical supplies. All of these factors put further strain on medical services, reducing the quality of care available to victims of the blast, alongside day-to-day patients.

Covid-19

It cannot be forgotten that the 4 August explosion occurred whilst Lebanon continued to contend with the Covid-19 pandemic and the additional demands it placed on the country's healthcare sector.

Thankfully, when the port explosion occurred, Lebanon had relatively low Covid-19 infection and

A wall-hanging outside St. George's Hospital, Beirut portraying experiences of medical personnel, Jake Tacchi (2021).

hospitalisation rates. This ensured that a greater number of intensive care unit (ICU) beds were available for those who had been seriously injured in the blast. However, data has shown that there was a significant rise in daily Covid-19 infections and deaths in the weeks and months following the blast.[96] There is no definitive reason as to why this was, but some have suggested that high levels of displacement caused by the explosion required families to reside in more crowded settings where the virus could spread more easily.[97]

Similarly, large protests and an extensive volunteer operation following the explosion likely contributed to higher rates of Covid within the community.[98] Regardless of the exact reasons behind the spike in cases, the Beirut blast and its aftermath was clearly a contributing factor, and further research is required to better understand how incidents of explosive violence can interplay with Covid-19 transmission and preparedness.

> ***At the hospital everything was shut down - all the systems, electricity, fire protection, elevators, telephone.***
>
> Dr Alexandre Nehme, Chief Medical Officer, St. George's Hospital, Beirut.[99]

Long-term Health Concerns

In the coming years it is clear that many of those injured in the blast will continue to suffer with both physical and psychological health conditions. This will have knock-on effects, increasing the burden on health services as well as the families of victims.[100]

UNIDIR's EWIPA indicators also highlight a number of 'third level' effects regarding changes to long-term health indicators such as mortality rates from cardiovascular disease or cancer.[101] Due to the relative proximity to the event, it may be some time before it is possible to attribute longer-term health problems to the Beirut Port explosion. Furthermore, Lebanon's ongoing economic crisis, as well as the global Covid-19 pandemic, may mean it will never be possible to accurately present direct causal links between the explosion and health indicators.

Despite this, the widespread destruction of health facilities, death of medical professionals and sudden intake of large numbers of injured individuals, certainly had, and continues to have, a significant impact on patient care. This is likely to contribute to changes in long-term health indicators, and an overall reduction in the quality of medical services in Beirut. Some have already suggested that there were significant and deeply harmful disruptions for those with existing conditions, like cancer, in the aftermath of the explosion.[102]

> ***"There is an increase in demand and a decrease in supply. That's a big stress on the healthcare system.***
>
> Dr. Gladys Honein, Hariri School of Nursing, AUB.[103]

It must also be noted that explosions involving ammonium nitrate release nitrogen oxides and ammonium gas which can cause long-term health concerns.[104] Nevertheless, due to the quantities released, and the prevailing wind direction on 4 August, it is unlikely that Beirut's citizens will suffer long-term health effects from gases released in the blast.[105] However, the large quantities of CDW produced from the explosion, alongside any potentially harmful chemicals that may have been stored at the port, may prove to have devastating long-term health effects.[106] Ongoing research related to CDW and 'toxic dust' produced during the Twin Towers' collapse on 9/11 continues to reveal strong links to serious and fatal long-term health conditions - particularly cancers.[107] Such conditions must continue to be monitored in Beirut, and further research is required to assess possible dangers to residents and to better ensure their long-term health.

Scaffolding remains on Beirut's St. George's Hospital, October 2021, Jake Tacchi (2021).

SDG 4 - Quality Education

> ***Explosive weapons can damage and destroy education facilities and thereby undermine the quality of and access to education from primary through to university level. When education facilities are damaged or destroyed, or access to utilities is interrupted, the facilities become inadequate for use, and the situation hinders the learning environment. Over an extended period of time, disrupted schooling and school closures affect educational attainment. This may lead to lifelong disadvantages for individuals and the wider society.***
>
> UNIDIR.[108]

Disruptions to Schooling

At least 178 schools were damaged in the 4 August explosion.[109] Initial assessments by the Lebanese Ministry of Education found that approximately 80% of schools in a 20km radius of the blast sustained 'light to moderate damage', whilst 20% sustained 'heavy damage'.[110]

It is thought that over 85,000 students were registered at schools damaged by the explosion, all of whom likely experienced at least some interruption to their schooling.[111] As the blast took place during summer holidays, however, disruptions were not as significant as they could have been. AOAV spoke with Gia Khoury, the headteacher at Beirut Annunciation Orthodox College, who revealed that the school, despite being badly damaged in the port explosion, was able to welcome students back on 15 September 2020, having had more than a month for preparations and reconstruction.[113] This being said, the school was not able to open all its facilities and many areas are still inaccessible today.

> ***There is barely a piece of glass not broken, and doors are smashed. The building's services are badly damaged too – the electricity supply is now in an exposed and dangerous condition, and all of our water supplies were cut.***
>
> Rudolph Abboud, Director of Collège Sacré-Coeur, Gemmayze.[112]

Other schools were not able to re-open so quickly, or were completely destroyed in the explosion, causing differing degrees of disruptions to a range of children across the city.

Whilst the Ministry of Education was able to find alternative places in other schools for the majority of children, this created further issues. For example, many students had to travel further distances to school, increasing transport costs and putting additional financial strain on poorer households.[114] Alongside this, undamaged schools often lacked the resources, staff and equipment to properly support extra students, likely reducing the quality of education received by all.

The psychological impact of the explosion on children is another significant factor affecting education. Regardless of physical damage to school facilities and disruptions to schooling, the trauma endured by large numbers of children in Beirut likely had, and will continue to have, adverse effects on education and attainment. For children, trauma can manifest in many ways, causing individuals to become withdrawn, unfocused or aggressive - all of which will have negative consequences on the student and their peers.[115]

> ***My school was damaged by the explosion and no one knows when it will reopen. I'll miss going to school. I'll miss studying, and I'll miss spending time with the teachers.***
>
> Hanan, 8, Karantina.[116]

Whilst psychologists have provided support for children and teachers in many schools, further research is required to better understand the links between explosive violence, child trauma and education.

Even though the EWIPA indicators include a range of long-term effects on education, the relative proximity to the event makes assessing such effects inherently difficult. This said, it cannot be denied that the Beirut port explosion has adversely impacted education in Beirut through the destruction of facilities and disruption to schooling.

Furthermore, the psychological impacts of the blast on children will continue to affect individual pupils and the education system at large, although this will differ significantly from school-to-school and pupil-to-pupil.

As is the case with health indicators, we may never be able to adequately measure or quantify the impacts the Beirut Port blast will have on education. The Covid-19 pandemic had already brought about significant disruptions to schooling in the months leading up to the explosion and attributing long-term changes in attainment to the blast would, therefore, raise a litany of methodological problems.

> ***We would do drawings, and some of the kids would draw the explosion, they would draw their houses on fire.***
>
> Rima, Borderless Project Manager, Karantina.[117]

The fourth floor of Beirut Annunciation Orthodox College, still unusable more than a year after the explosion, Jake Tacchi (2021).

Conclusion

As this report has shown, the 4 August port explosion irreversibly damaged the structural, social and cultural fabric of Beirut. Residents saw their lives change in a moment and many will never fully recover from the intense psychological toll brought about by the death, injury and material destruction inflicted on the city and its citizens.

Beyond the significant and devastating loss of life, this event negatively impacted on the health, livelihoods and opportunities of individuals - upsetting the ecosystem of facilities and services which support life in populated areas.

Homes were destroyed and key services were interrupted, preventing citizens from living safely and with dignity. Health services were damaged, affecting emergency response and leaving a lasting scar on citizens' ability to access quality healthcare. The destruction of education facilities, disruption to schooling and mental health impacts on students are likely to have lasting effects on the children of Beirut.

This case study provides a key example of the wide-ranging and interwoven humanitarian consequences of a large explosion in a populated area. It is hoped that the analysis in this report is relevant to both industrial explosions (involving ammonium nitrate or otherwise) and wider use of explosive weaponry. AOAV believes this report can be used to better understand the dangers posed to civilians when an explosion of this size occurs within a densely populated city.

It has been beyond the remit of this report to fully assess the culpability of the Lebanese state or its negligence in the aftermath of the explosion. AOAV does, however, hope to support any work which looks to establish truth, justice and accountability related to the explosion.

Lebanon: the EU's response to the tragic explosions in Beirut, EU Civil Protection and Humanitarian Aid (CC BY-NC-ND 2.0).

Despite an ineffective state response, the actions and resilience of Beirut's emergency services, medical personnel and citizens should be commended. The immediate, dynamic and tireless response of individuals in Beirut to address impacts of the explosion, undoubtedly saved lives and mediated many of the blast's worst effects. In Beirut, 44% of individuals, aged 18-25, volunteered in some way to rehabilitate the city and its residents in the aftermath of the explosion.[118] At the St. George's Hospital, the Chief Medical Officer admitted that every day, for three weeks after the blast, 400-500 volunteers came to help in the cleanup of the building.[119]

The longer-term impacts of the Beirut Port explosion still remain to be seen. The resilience of citizens and the efforts of local actors to counter the blast's effects on a range of key services will, undoubtedly, heal the city's scars in part. However, further research, monitoring and analysis should be encouraged to better understand these lasting effects, and to ensure victims are able to access relevant and adequate support.

As is always the case with explosive violence, it cannot be removed from the wider socio-political and economic environment in which it exists. The 4 August port explosion quickly became interwoven with Lebanon's other woes: the ongoing political crises, its historic economic slump and the wider, unprecedented global pandemic. It may never be possible to fully gauge the direct and indirect impacts of the explosion due to these other factors, but we can say without question that the port blast massively increased an environment of precarity already faced by Beirut's citizens and the city at large.

The damage caused in a single moment cannot be overplayed. It was epoch defining, shaping resident's lives along the lines of pre-blast and post-blast. Every effort must be made to ensure a tragedy of this scale never occurs again.

Protests outside the Lebanese Ministry of Justice, Beirut, 29 Sep 2021, Jake Tacchi (2021).

Recommendations

- AOAV fully supports the requests made by Legal Action Worldwide for a United Nations fact-finding mission to investigate the root causes of the Beirut explosion.[120]

- An independent, impartial and uninterrupted inquiry must be carried out to assess the exact causes of the blast and hold accountable those responsible for the death and destruction witnessed in Beirut on 4 August 2020.

- The international community should make efforts to develop universal guidelines regarding the storage of ammonium nitrate, prosecuting individuals and states that fail to meet key safety measures.

- Governments, organisations and individuals should continue to pursue monitoring and research which records the ongoing effects of the Beirut explosion. This is essential to provide a better understanding of the long-term consequences of explosive violence in populated areas and to ensure the victims of this horrific disaster receive the support they require.

- All states should consider becoming signatories to the proposed political declaration that seeks to address the humanitarian harm arising from the use of explosive weapons in populated areas.

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