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Predictors and severity of probable acute stress disorder following the Beirut Port Blast

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ABSTRACT

Background: The Beirut Port Blast on August 4, 2020 is the largest (non-nuclear) explosion on record. St George Hospital University Medical Center (SGHUMC), a leading academic medical centre in Lebanon, adjacent to the Port, sustained a massive loss in lives and infrastructure.
Objective: The current study uses the baseline data of an ongoing longitudinal study to explore the prevalence, severity, and predictors of probable Acute Stress Disorder (ASD) among health workers at SGHUMC following the blast.
Methods: In the context of COVID-19 tests administered 9–15 days after the blast, SGHUMC staff were asked to complete a questionnaire that included socio-demographic details, the Beirut Port Exposure Inventory, and the Acute Stress Disorder Scale (ASDS).
Results: A total of 570 health workers participated in the study. The prevalence of probable DSM-5 ASD [95%CI] was 38.34% [31.41; 45.32]. Many specific exposures were related, on a bivariate level, to ASD be it as a probable DSM-5 diagnosis or its severity as measured by the ASDS. A classification and regression tree (CART) analysis identified the highest risk predictors of probable DSM-5 ASD diagnosis to be: being a female, seeing dead or mutilated bodies, death of a close one, and being scared at the time of the explosion. Nurses carried the highest risks of all health workers with a probable DSM-5 ASD prevalence of 51.28%, (OR = 3.72 [95% CI: 2.22; 6.25]). Being scared at the time of the blast was the most single predictor of probable ASD.
Conclusion: Both the prevalence and severity of probable DSM-5 ASD in this sample are higher than most reported in the literature, which may be explained by the severity of the trauma and the ongoing stress in the context of the pandemic. Fear at the time of the explosion was independently the most predictive parameter of probable ASD.

Predictores y Gravedad del probable Trastorno de Estrés Agudo después de la Explosión del Puerto de Beirut

Antecedentes: La explosión del Puerto de Beirut el 4 de agosto de 2020 es la explosión (no nuclear) más grande registrada. El Centro Médico Universitario del Hospital St George (SGHUMC), un centro médico académico líder en el Líbano, adyacente al puerto, sufrió una pérdida masiva de vidas e infraestructura.
Objetivo: El estudio actual utiliza los datos iniciales de un estudio longitudinal en curso para explorar la prevalencia, gravedad y predictores del probable Trastorno de Estrés Agudo (TEA) entre los trabajadores de la salud en SGHUMC después de la explosión.
Métodos: En el contexto de las pruebas de COVID-19 administradas entre 9 y 15 días después de la explosión, se le pidió al personal de SGHUMC que completara un cuestionario que incluía detalles sociodemográficos, el Inventario de Exposición del Puerto de Beirut y la Escala de Trastorno de Estrés Agudo (ETEA).
Resultados: Un total de 570 trabajadores de la salud participaron en el estudio. La prevalencia de probable TEA DSM-5 [IC 95%] fue del 38,34% [31,41; 45.32]. Muchas exposiciones específicas se relacionaron, en un nivel bivariado, con TEA, ya sea como un diagnóstico probable del DSM-5 o su gravedad medida por el ETEA. Un análisis del árbol de clasificación y regresión (CART, por sus siglas en inglés) identificó que los predictores de riesgo más alto del diagnóstico probable

HIGHLIGHTS
- On 4 August 2020, 2700 tons of ammonium nitrate exploded in the port of Beirut.
- 38.34% of all health workers and 51.2% of nurses at St Georges Hospital University Medical Center, which faces the port, had probable DSM-5 ASD in this ongoing longitudinal study.

de TEA según el DSM-5 son: ser mujer, ver cuerpos muertos o mutilados, la muerte de alguien cercano y tener miedo en el momento de la explosión. Las enfermeras tenían los riesgos más altos de todos los trabajadores de la salud con una prevalencia probable de TEA según el DSM-5 del 51,28%, (OR = 3,72 [IC del 95%: 2,22; 6.25]). Sentirse aterrorizados en el momento de la explosión fue el predictor más determinante de probable TEA.

Conclusión: Tanto la prevalencia como la gravedad del probable TEA DSM-5 en esta muestra son más altas que la mayoría de las reportadas en la literatura, lo que puede explicarse por la gravedad del trauma y el estrés continuo en el contexto de la pandemia. El miedo en el momento de la explosión fue independientemente el parámetro más predictivo de probable TEA.

贝鲁特港口爆炸后可能的急性应激障碍的预测因素和严重程度

背景: 2020 年 8 月 4 日的贝鲁特港口爆炸是有记录以来最大的 (非核) 爆炸。圣乔治医院大学医学中心 (SGHUMC) 是黎巴嫩领先的学术医疗中心，毗邻港口，在生命和基础设施方面遭受了巨大损失。

目的: 本研究使用正在进行的纵向研究的基线数据来探索爆炸后 SGHUMC 卫生工作者中可能的急性应激障碍 (ASD) 的患病率、严重程度和预测因素。

方法: 在爆炸后 9-15 天进行 COVID-19 检测的背景下，SGHUMC 工作人员被要求完成一份问卷，其中包括社会人口学细节、贝鲁特港口暴露量表和急性应激障碍量表 (ASDS)。

结果: 共有 570 名卫生工作者参与了研究。可能的 DSM-5 ASD [95%CI] 的患病率为 38.34% [31.41; 45.32]。许多特定暴露在双变量水平上与 ASD 相关，无论是作为可能的 DSM-5 诊断还是通过 ASDS 测量的严重程度。分类和回归树 (CART) 分析确定了可能的 DSM-5 ASD 诊断的最高风险预测因子是:作为女性、看到尸体或残缺不全的尸体、亲近的人死亡以及在爆炸时感到害怕。在所有卫生工作者中，护士的风险最高，可能的DSM-5 ASD 患病率为 51.28%, (OR = 3.72 [95% CI:2.22; 6.25])。在爆炸发生时感到害怕是可能的 ASD 最单一的预测因素。

结论: 该样本中可能的 DSM-5 ASD 的患病率和严重程度均高于文献中报道的大多数，这可能是由于创伤的严重程度和疫情背景下的持续应激所致。爆炸时的恐惧独立地是可能的 ASD 最具预测性的参数。

1. Introduction

Disasters occur frequently across the globe and some of them stand out by their scale of destruction and losses. On 4 August 2020, a distinctive disaster occurred in Lebanon when there was an explosion of approximately 2,700 tons of ammonium nitrate. It occurred in the port of Beirut, and the blast registered as a magnitude 3.3 on the Richter scale (Gibbens, 2020). It was calculated to be the third-largest explosion in the world following Nagasaki and Hiroshima, thus the strongest non-nuclear explosion on record. The blast resulted in approximately 200 fatalities, 6,500 injured, 300,000 displaced, and widespread destruction of property and infrastructure in Beirut, which was already adversely affected by severe economic and political turmoil in the context of the COVID-19 pandemic.

Relevant to the acute stress response to disasters such as the explosion is the Acute Stress Disorder (ASD) diagnosis, which was first introduced in the Diagnostic and Statistical Manual of Mental Disorders 4th edition (DSM-IV) to describe acute stress responses before Postraumatic Stress Disorder (PTSD) potentially being diagnosed at one month after trauma exposure (Cardena & Carlson, 2011). Whereas the initial conceptualization of ASD in DSM-IV emphasized the role of acute dissociative symptoms and the capacity of ASD to predict later

PTSD, subsequent evidence indicated that whereas ASD is predictive of PTSD, most people who eventually develop PTSD do not initially meet the ASD criteria (Bryant, 2011). As a result, the criteria for ASD was refined in the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5) to require that other than being exposed to a traumatic event, a person needed to experience nine out of 14 symptoms (of intrusion, negative mood, arousal, dissociation, and avoidance) to qualify for a diagnosis of ASD (American Psychiatric Association, 2013). A major driver for this diagnosis in DSM-5 was to facilitate the identification of people severely distressed in the acute phase who might benefit from mental health assistance (Bryant, Friedman, Spiegel, Ursano, & Strain, 2011). It is worth noting that the Acute Stress Disorder in the International Classification of Diseases-11 (ICD-11) is no longer considered as a disorder, but is a 'legitimate focus of clinical intervention' (Maercker et al., 2013). Acute stress disorder has been studied after diverse traumatic events, with prevalence rates varying widely across studies and types of trauma. One systematic review reported that rates of ASD vary between interpersonal trauma (36.0%), accidents (15.9%), disasters (21.9%), life-threatening illness (20.7%), and war-related trauma (14.1%) (Ophuis, Olij, Polinder, & Haagsma, 2018). The

relevance of ASD is that apart from describing people with severe acute posttraumatic stress, the diagnosis also possesses some predictive power in identifying people who are at greater risk for developing PTSD, as well as a range of other psychiatric disorders (Bryant et al., 2015).

ASD can be influenced by a range of factors. One important issue is the role of various aspects of the traumatic event since the reaction to trauma is theoretically directly linked to the variety and degree of specific aspects which characterize that event (Brewin, Andrews, & Valentine, 2000). Exposure has been measured in different ways that attempt to provide quantifiable metrics of exposure, such as following earthquakes (distance from the epicentre) (Goenjian, Khachadourian, Armenian, Demirchyan, & Steinberg, 2018), wars (number and degree of witnessing of events) (Karam, Al-Atrash, Saliba, Melhem, & Howard, 1999), and explosions (casualties, level of destruction) (Boscarino et al., 2004; de Bocanegra & Brickman, 2004; DeLisi et al., 2003; Galea et al., 2002; Jhangiani, 2010). Other risk factors for ASD development include female gender and younger age (Fuglsang, Moergeli, & Schnyder, 2004; Hansen & Elklit, 2011; Jhangiani, 2010), being afraid during the exposure (Fuglsang et al., 2004), sense of a death threat (Fuglsang, Moergeli, Hepp-Beg, & Schnyder, 2002), and overall satisfaction with received support (Fuglsang et al., 2004; Hansen & Elklit, 2011; Holeva, Tarrier, & Wells, 2001), in addition to pre-exposure variables such as previous trauma and trauma severity (Hansen & Elklit, 2011), trait anxiety, and prior PTSD (Harvey & Bryant, 2015; Suliman, Troemanb, Stein, & Seedat, 2013).

Whereas there have been studies on ASD following traumatic injury, assaults, natural disasters, and the COVID-19 pandemic (Bryant, 2011; Ophuis et al., 2018), there has been scant attention on ASD following technological disasters. There is some evidence that technological disasters may trigger more severe stress reactions (Bromet, 2014; Goldmann & Galea, 2014), however studies have not specifically examined ASD in this context. One study reported stress reactions longitudinally following the Fukushima nuclear accident, however, this study did not formally assess ASD (Sato, Techasrivichien, Omori, Ono-Kihara, & Kihara, 2019).

The current study aimed to fill this gap by examining the acute stress reactions of the Beirut Port Blast by estimating the prevalence, severity, and predictors of probable ASD in a highly exposed population. The Saint George Hospital University Medical Center (SGHUMC), a leading academic medical centre in Lebanon, was severely hit because of its direct exposure to the port and was rendered non-operational. More than 100 staff sustained injuries and some were killed (SGHUMC, 2020). At the time of the explosion, many staff witnessed scenes of mutilated bodies, chaos, total incapacity of essential medical equipment, and the challenge of trying to provide required medical assistance to survivors when the emergency department and much infrastructure were destroyed.

2. Methods

2.1. Participants

Participants were health workers at Saint George Hospital University Medical Center (SGHUMC). The hospital administration urged the staff to undertake a Polymerase Chain Reaction (PCR) testing for COVID-19 between August 13 and 19, 2020 (9–15 days after the Beirut Port Blast; mean 10.43 days ± 2.26 days). The SGHUMC decision was initiated because a large number of the staff were potentially exposed to unprotected others because of the turmoil during the blast. The final sample consisted of 570 participants. Given the urgency and the chaotic setting, we could not calculate the response rate as we could not monitor the exact number of people who undertook a PCR test, but the refusal rate was 'low' according to anecdotal reports from field members.

2.2. Procedures

Following an email from the SGHUMC to staff asking them to report for COVID-19 testing between the 13th and the 19th of August, assessors were present at the testing locations at SGHUMC. They approached SGHUMC staff to explain briefly that a study was being conducted to assess reactions following the Beirut Port Blast. Following oral informed consent, participants were provided with a printed assessment battery in English or Arabic (based on their preference). This study was approved by the Institutional Review Board (IRB) committee of the SGHUMC Faculty of Medicine, University of Balamand, Lebanon, which is registered with the U.S Office of Human Research Protections (OHRP) in the Department of Health and Human Services. IRB approval Number IRB-REC/O/050-20/3120.

2.3. Instrument and measures

The questionnaire included in addition to sociodemographics (age, gender, and profession), the Beirut Port Exposure Inventory (prepared by the Institute for Development, Research, Advocacy and Applied Care (IDRAAC): see Appendix 1) and the Acute Stress Disorder Scale (Bryant, Moulds, & Guthrie, 2000).

2.3.1. Beirut Port Blast Exposure Inventory

This scale consists of nine questions which address specific types of exposure to the Beirut Port Blast and included: location at the time of the explosion,

personal physical injuries and their degree (mild, moderate, severe), problems in receiving any needed medical attention, severe injury or death of a close person, damage to the place of residence and severity, participating in rescue efforts at or outside the hospital, the extent of the injuries of the people rescued (light, moderate or severe), and seeing any mutilated or dead bodies. Exposure was measured in terms of specific exposures (being personally injured, having a close one who died, having a close one severely injured, having a close one moderately or mildly injured, having a place of residence that was at least moderately affected, participation in rescue efforts, and seeing dead/mutilated bodies), the number of exposure events, and the weighted exposure score. For the number of events score, the respondent received one point for each of the following exposures: being personally injured, having a close one who died, having a close one severely injured, having a close one moderately or mildly injured, having a place of residence that was at least moderately affected, participation in rescue efforts and seeing dead/mutilated bodies (maximum score = 7). To generate the exposure score based on the cumulative weights of exposure events, we asked a panel of 20 experts from our department (clinicians, statisticians, public health experts) to give a weight to each event ranging from 0 to 100. The final weight attributed to each exposure was the median of all reported weights for this event by the panel. The final weighing score was the cumulative score of all the events experienced and the weights attributed to them. It is worth noting that there is a 'common exposure' which refers to universal exposure of all subjects who were in and around the Port of Beirut Blast which was felt far beyond the confines of where the participants were at the time of the explosion and did not endorse any of the specific items measured by our survey. This common exposure included the sound of the blast, the sight of the destruction, and the experience of the brunt of the blast against themselves and/or property.

2.3.2. Acute Stress Disorder Measures

The most established instrument to measure ASD as a self-report is the Acute Stress Disorder Scale (ASDS; Bryant et al., 2000). It has good psychometric characteristics when validated against the Acute Stress Disorder Interview (ASDI) for DSM-IV with a sensitivity of .95, specificity of .83, positive predictive value (PPV) of .80, and a negative predictive value (NPV) of .96 (Bryant et al., 2000). The Acute Stress Disorder Scale consists of 21 items, 19 of which ask about symptoms of acute stress following a trauma. Each of these 19 items is coded on a 5-point scale (1 = *not at all*, 5 = *very much*) and the summation of scores provides a total severity score. A total score of 56 on the ASDS can be used as a cut-off for later

prediction of PTSD (sensitivity: 0.91, specificity: 0.93, PPV: 0.67, NPV: 0.98; Bryant et al., 2000). Participants were also asked if they experienced fear (Bryant et al., 2000) and the extent to which any symptoms interfered with occupational or personal functioning. The original English ASDS scale was translated to Arabic by members of our team and back-translated to English by a professional translator. The ASDS is not standardized in the Arabic Language. The internal consistency (Cronbach's alpha) in the current sample was 0.94. To derive a probable DSM-5 compatible definition of PTSD, the 14 relevant symptoms were used to derive a probable ASD diagnosis by endorsing at least 9 symptoms (Bryant, 2016).

2.4. Statistical analysis

At the univariate level, frequencies and percentages were generated for categorical variables and means and standard deviations for continuous variables. The prevalence of probable ASD with 95% Confidence Intervals (CI) using the 56 cut-off and the DSM-5 binary variables was generated. A Receiver Operating Characteristic curve (ROC) curve with an Area Under the Curve (AUC) and sensitivity analyses were conducted to check for the optimal cut-off score of the ASDS cut-off. Simple and multiple logistic regressions were conducted for the ASDS continuous score (linear) and the ASDS cut-off 56 and probable DSM-5 ASD (logistic). A final model was reported for different ways of measuring the outcome. In logistic regressions, crude and adjusted Odds Ratios (OR) with their 95% CI were generated. Statistical significance was set at 0.05 and borderline significance at 0.10. STATA version 13.0 was used to conduct the statistical analyses. A classification and regression tree (CART) analysis was conducted for the ASDS scores and probable DSM-5 ASD to identify the most affected groups.

3. Results

3.1. Participant's demographic characteristics

The mean age of the participants was 34.06 ± 11.16 years (range, 20–73 years). Most respondents were female (N = 372; 65.38%), and they were distributed across a number of professions, including nurses (N = 218; 41.13%), non-clinical staff (N = 139; 26.23%), physicians and residents (N = 91; 17.17%), medical students (N = 38; 7.17%), and allied health staff (N = 44;8.30%) (see Table 1).

3.2. Blast Exposure

Approximately half of the participants were at home (N = 292; 51.3%) and a quarter (N = 139; 24.43%)

Table 1. Description of study participants and frequencies of exposures to Beirut Port blast (*N* = 570).

	N (%)
Age ^	34.05 ± 11.14
Gender	
Male	197 (34.62)
Female	372 (65.38)
Profession	
Others (nonclinical)	139 (26.23)
Physicians	12 (2.26)
Residents	79 (14.91)
Medical students	38 (7.17)
Nurses	218 (41.13)
Others (clinical)	44 (8.30)
Location at the time of the explosion	
Hospital	139 (24.43)
House	292 (51.32)
Street	93 (16.34)
Others	45 (7.91)
Physical injuries to self (severity)	
No	434 (77.09)
Mild	111 (19.72)
Moderate/Severe	18 (3.20)
Death of a close one	
No	396 (74.16)
Yes	138 (25.84)
Severe injuries of a close one	
No	355 (66.73)
Yes	177 (33.27)
Moderate or mild injuries of a close one	
No	261 (49.81)
Yes	263 (50.19)
Place of residence affected	
No	262 (48.88)
Moderate	194 (36.19)
Severe/complete	80 (14.93)
Participation in rescue efforts	
No	235 (43.52)
Light injuries	93 (17.22)
Moderate injuries	90 (16.67)
Severe injuries	122 (22.59)
Seeing dead/mutilated bodies	
No	235 (43.28)
Yes	308 (56.72)
Frightened by the experience	
No	107 (19.74)
Yes	435 (80.26)
Exposure score based on weights^	204.20 ± 124.66
Number of exposure events	
Common*	45 (9.11)
1	64 (12.96)
2	90 (18.22)
3	102 (20.65)
4	93 (18.83)
5	69 (13.97)
6+	31 (6.28)
Exposure scores based on number of events^	2.94 ± 1.68

^mean ± SD for continuous variables.
*unmeasured (see article for details).

were at the hospital (Table 1) at the time of the explosion. In terms of personal injury, 22.92% (*N* = 129) were injured, and 26.6% (*N* = 35) of the injured reported difficulty in receiving needed medical attention. Respondents reported severe (*N* = 177; 33.27%) or mild/moderate (*N* = 263; 50.19%) injuries to close ones; 25.84% (*N* = 138) reported the death of a close one. Approximately half of respondents reported having their residence damaged by the explosion (*N* = 274; 51.12%), including moderate (glass shattered, doors broken; *N* = 194; 36.19%) and severe destruction (needs major work and currently inhabitable; *N* = 80; 14.93%). Approximately half of respondents (*N* =

305; 56.48%) participated in rescue efforts of patients in the hospital or other injured people outside the hospital and more than half (*N* = 308; 56.72%) reported seeing dead/mutilated bodies (see Table 1).

3.3. Prevalence of probable ASD

Of the 570 respondents, 473 responded on all 19 ASDS scores. ASDS scores were imputed for 51 individuals who had one or 2 missing items and were not imputed for 46 respondents who had more than 2 items missing. The mean ASDS score was 48.76 ± 16.65 (range: 19–90 (possible maximum score is 95)). The prevalence of probable ASD using the ASDS 56 cut-off was 36.1% [95% CI: 29.14; 43.26]. The prevalence of probable ASD using the DSM-5 definition was 38.3% [95% CI: 31.41; 45.32] (see Table 2). Respondents who were exposed to the general blast but did not endorse any of the specific direct exposure events still reported a high rate of probable DSM-5 ASD (26.19%) and almost one in five (19.05%) scored above the severity 56 cut-off on the ASDS (predictor of future DSM PTSD), with a mean of 41.69 ± 13.97.

3.4. Association between probable DSM-5 ASD and ASDS

The prevalence of probable DSM-5 ASD, 38.34%, was almost the same as that generated by the ASDS cut-off 56 (36.07%). The agreement of probable ASD screening between the two measures was 89.98% (Kappa agreement of 0.78). In terms of the extent to which the ASDS cut-off 56 could predict probable DSM-5 ASD, we found good sensitivity (84.42% of those who met DSM-5 criteria were above cut-off 56), specificity (93.43% of those who did not meet DSM-5 criteria were below 56 cut-off), positive predictive value (PPV: 88.88% of those who scored above 56 cut-off met the DSM-5 criteria), and negative predictive value (NPV: 90.60% of those who scored below 56 cut-of did not meet DSM-5 criteria). We also examined the ROC curve for ASDS with the probable DSM-5 ASD to determine the optimal cut-off. We found a score of 53 generated a slightly higher prevalence of probable ASD than the 56 cut-off: 40.65% [95% CI: 34.17; 47.77] vs. 36.07%. The 53 cut-off produced good sensitivity (91.50%), specificity (90.60%), PPV (85.85%), NPV (94.46%) measures. It produced an AUC of 0.97 (*p* < 0.001), demonstrating excellent discriminatory power.

3.5. Predictors of ASDS continuous score

At the bivariate level, several variables were associated with ASDS score: some were protective such as increasing age and being an attending physician (as compared to non-clinical staff), and others increased

Table 2. Acute stress disorder scores (ASDS) and DSM5 Acute Stress Disorder (N = 524).

		ASDS total score			DSM-5 ASD		
		N	Mean ± SD	p-value	N	Prevalence (95%CI)	p-value
Total		524	48.76 ± 16.65		199	38.34 (31.41;45.32)	
Gender	Males	181	41.04 ± 14.82	<0.001*	38	21.23 (9.55; 37.32)	<0.001*
	Females	343	52.85 ± 16.14		161	47.35 (39.3; 55.22)	
Age^	≤26	176	51.15 ± 16.92	0.0034*	78	44.83 (33.59; 56.56)	0.009*
	[26;35]	175	49.46 ± 16.93		70	40 (28.47; 52.41)	
	>35	156	45.12 ± 15.79		44	28.57 (16.76; 45.2)	

^Age is categorized according to tertiles.
*p-value < 0.05.

risk for probable ASD, such as female gender and clinical staff (except attending physicians). Both ways of scoring specific exposures (number of events score and the weighted exposure score) were also associated with higher ASDS scores. Being at the hospital at the time of the explosion (compared to those who were at home) trended as being predictive of higher ASDS scores (house as compared to hospital: $B = -3.32$ [95% CI: −6.83; 0.19]), with a borderline significance ($p = 0.064$). Other individual exposures were more solidly associated with higher ASDS scores (see Supplementary Figure 1). Lastly, being frightened by the experience was a strong predictor of an increased ASDS score (see Table 3).

In the multiple linear model taking individual specific exposures together with age, gender, profession, and feeling scared: younger age ($B = -0.21$ [95% CI: −0.36; −0.06]), female gender ($B = 6.82$ [95% CI: 3.91; 9.48]) and nurses as a profession remained predictors of higher ASDS score ($B = 5.45$ [95% CI: 1.77; 9.12]). Personal moderate or severe injuries to self ($B = 10.83$ [95% CI: 4.04; 17.61]), death of a close one ($B = 4.90$ [95% CI: 1.57; 8.22]) and mild/moderate injuries to a close one (OR = 2.90 [95% CI: 0.10; 5.69]) were the three individual exposures which remained significant (see Table 4). Additionally, when exposure was considered globally, and adjusting for age, gender, profession and if the person was frightened by the experience, both scores of exposure remained associated with higher ASDS scores: the weighted exposure score (above common exposure) $B = 0.03$ [95% CI: 0.01; 0.04] and the number of events score (also over and above common exposure) $B = 1.95$ [95% CI: 1.11; 2.79]. For the number of events, being exposed to 1–3 events was not significantly associated with ASDS continuous score compared to common exposure, as defined by being in Beirut at the time blast but not endorsing any of the specific direct exposure events ($B = 4.17$; [95% CI: −0.89; 9.25]). Being exposed to 4 + events however was significantly associated with ASDS continuous score compared to common exposure ($B = 9.67$ [95% CI: 4.37; 14.98]).

In terms of measuring trauma exposure by the individual events, age, gender and profession explained 17.55% of the total variance in ASDS scores, which

increased to 23.21%, after including the individual specific exposure items, and to 32.77% when adding if fear during the event. When measuring exposure as a count, including the number of events to the model that included age, gender and profession increased the explained variance from 17.55% to 22.06%, which further increased to 32.21% after adding fear during the event. Finally, when measuring exposure as a weighted score and adding it to age, gender, and profession the variance in ASDS scores increased from 17.5% to 22.10%, which increased further to 32.77% after adding feeling fear.

The CART analysis of the ASDS scores ranked feeling scared during the blast as the first factor which predicted higher ASDS scores with a mean score (SD) of 52.23(15.83). The group that had the highest mean of ASDS scores was females who were afraid and who saw dead/mutilated bodies, with a mean (SD) ASDS score of 58.39 (15.36).

3.6. Predictors of Probable DSM-5 ASD

At the bivariate level, predictors of probable ASD (DSM-5) were lower age, female gender, being a medical student a nurse, or other clinical staff, having moderate or severe injuries, having someone close die, sustained severe injuries, or mild/moderate injuries, having one's place of residence severely or totally destroyed, seeing dead/mutilated bodies, and being frightened by the experience (OR = 10.61 [95% CI: 5.03; 22.04]; see Supplementary Figure 2). The above findings were similar to those found in continuous scores of ASDS except for being an attending physician or a resident, being at home during the explosion as compared to being at the hospital, sustaining mild injuries and participating in rescue efforts. Both total exposure scores (the number of events and the weighted score of these events) were significant predictors, however with only moderate effects (see Table 3).

In the multiple regression model taking individual exposures together with age, gender, profession and feeling scared, female gender (OR = 2.03 [95% CI: 1.21; 3.39]), nurses (OR = 3.06 [95% CI: 1.63; 5.74]), medical students (OR = 2.78 [95% CI: 1.04; 7.43]) and younger age ($p = 0.028$; OR = 0.97 [95% CI: 0.95;

Table 3. Predictors of Acute stress disorder scores (ASDS) and of ASD DSM-5, at the bivariate level (*N* = 524).

	ASDS continuous score				ASD DSM-5			
	B	95% CI: lower bound	95% CI: upper bound	*p*-value	OR	95% CI: lower bound	95% CI: upper bound	*p*-value
Age	−0.24	−0.38	−0.11	<0.001*	0.97	0.95	0.99	0.002*
Gender (Female)	11.8	8.97	14.63	<0.001*	3.34	2.2	5.06	<0.001*
Profession								
Others (nonclinical) *(ref)*								
Physicians	−9.64	−19.19	−0.88	0.048*	0.32	0.04	2.61	0.288
Residents	6.05	1.49	10.62	0.009*	1.54	0.81	2.95	0.189
Medical students	7.37	1.5	13.24	0.014*	3.18	1.47	6.89	0.003*
Nurses	10.46	6.81	14.11	<0.001*	3.72	2.22	6.25	<0.001*
Others (clinical)	8.41	2.8	14.01	0.003*	2.55	1.21	5.37	0.014*
Location at the time of the explosion								
Hospital *(ref)*								
House	−3.32	−6.83	0.19	0.064	0.89	0.58	1.37	0.597
Street	−0.34	−4.93	4.24	0.883	1.27	0.72	2.22	0.41
Others	−3.01	−8.68	2.64	0.296	0.77	0.38	1.57	0.474
Physical injuries to self (severity)								
Mild	3.95	0.36	7.55	0.031*	1.18	0.75	1.84	0.472
Moderate/Severe	12.84	5.03	20.66	0.001*	2.71	1.03	7.14	0.044*
Trouble getting the needed medical attention if physically injured	2.37	−4.12	8.87	0.47	1.28	0.56	2.91	0.563
Death of a close one	7.41	4.11	10.71	<0.001*	2.24	1.48	3.38	<0.001*
Severe injuries of a close one	5.08	2	8.15	0.001*	1.67	1	2.15	0.049*
Moderate or mild injuries of a close one	6.74	3.87	9.62	<0.001*	2	1.38	2.89	<0.001*
Place of residence affected								
Moderately	1.1	−2.06	4.26	0.495	0.79	0.53	1.18	0.253
Severely/completely	5.25	1.05	9.44	0.014*	2	1.2	3.33	0.008*
Participation in rescue efforts								
Light injuries	−0.84	−4.92	3.24	0.685	0.89	0.53	1.48	0.64
Moderate injuries	2.8	−1.29	6.91	0.179	1.29	0.78	2.12	0.321
Severe injuries	−2.16	−5.9	1.56	0.254	0.85	0.53	1.36	0.497
Seeing dead/mutilated bodies	3.29	0.4	6.18	0.026*	1.45	1	2.09	0.045*
Frightened by the experience	17.24	14	20.49	<0.001*	10.61	5.03	22.4	<0.001*
Exposure score based on weights	0.03	0.01	0.04	<0.001*	1.002	1.001	1.004	<0.001*
Exposure scores based on number of events	2.26	1.37	3.14	<0.001*	1.2	1.07	1.34	0.002*

*p-value < 0.05.

1.00]) significantly predicted probable DSM-5 ASD. Death of a close one remained a significant predictor of probable ASD DSM-5 (OR = 1.79 [95% CI: 1.06; 3.04]). The individual exposures that were not associated in the final model with ASDS continuous score but were found to be predictive of the probable DSM-5 ASD were: the place of residence being severely or totally destroyed (OR = 2.03 [95% CI: 1.05; 3.91]) and seeing dead or mutilated bodies (OR = 1.67 [95% CI: 1.04; 2.67] see Table 4). Finally and consistently with what was found in the case of ASDS continuous score, when the number of events exposure score was regressed on the DSM-5 while adjusting for age, gender, profession, and being scared of the experience, it remained a significant predictor (OR = 1.19 [95% CI: 1.04; 1.37]) of meeting criteria of probable DSM-5 ASD diagnosis. When examining the different categories of the number of events exposure, neither being exposed to 1–3 events (compared to common exposure) was a significant predictor of probable DSM-5 ASD (OR = 1.56 [95% CI: 0.62; 3.91]) nor was being exposed to 4 + events (which had marginal significance; OR = 2.28 [95% CI: 0.88; 5.92]). Finally, weighted exposure scores were also associated with probable DSM-5 ASD. Higher scores were more likely to be predictors of meeting criteria of probable DSM-5 ASD: scores

above 400 had an OR of 3.05 [CI 1.07; 8.67] and scores 300–399 an OR of 2.88 [95%CI: 1.28; 6.48]. Scores of 200–299 also had increased odds but with borderline significance OR = 1.99 [95%CI: 0.93; 4.31]. Lower scores did not demonstrate any significant association.

The CART analysis of the probable DSM-5 ASD Diagnosis revealed similar findings to the CART of the ASDS scores in terms of factors inclusion and ranking. Again, feeling scared was the first factor that predicted having probable DSM-5 ASD with a probability of 46.7%. The group that had the highest probability of probable DSM-5 ASD was females who were afraid and who saw dead/mutilated bodies, with a 61.7% probability. When removing fear from the CART analysis, females who experienced the death of a close one had the highest probability of probable ASD DSM-5 (60.6%), followed by females who saw dead/mutilated bodies (48.7%) and males who are nurses or medical students (32.9%).

3.7. Predictors of ASDS 56 and 53 cut-offs

At the bivariate levels, the findings for the cut-off of 56 on the ASDS, are similar to those found for the DSM-5 on every factor. At the multivariable level, the predictors of the cut-off 56 are the same as the ones of the

Table 4. Predictors of Acute stress disorder scores (ASDS) and of DSM-5 ASD at the multivariable level (N = 524).

	ASDS total score				ASD DSM-5			
	B	95% CI lower bound	95% CI upper bound	p-value	Odds Ratio	95% CI lower bound	95% CI upper bound	p-value
Age	−0.21	−0.36	−0.06	0.007*	0.97	0.95	1.00	0.028*
Gender (Female)	6.82	3.91	9.48	<0.001*	2.03	1.21	3.39	0.007*
Profession								
Others (nonclinical) *(ref)*								
Physicians	−5.18	−13.76	3.39	0.23	0.55	0.06	5.05	0.60
Residents	2.89	−1.70	7.48	0.22	1.10	0.50	2.45	0.81
Medical students	3.29	−2.60	9.18	0.27	2.78	1.04	7.43	0.042*
Nurses	5.45	1.77	9.12	0.004*	3.06	1.63	5.74	<0.001*
Others (clinical)	3.09	−2.33	8.50	0.26	1.97	0.80	4.82	0.14
Physical injuries to self (severity)								
Mild	0.69	−2.83	4.21	0.70				
Moderate/Severe	10.83	4.04	17.61	0.002*				
Death of a close one	4.90	1.57	8.22	0.004*	1.79	1.06	3.04	0.030*
Severe injuries of a close one								
Moderate or mild injuries of a close one	2.90	0.10	5.69	0.042*				
Place of residence affected								
Moderately					0.75	0.46	1.22	0.25
Severely/completely					2.03	1.05	3.91	0.035*
Seeing dead/mutilated bodies	2.75	−0.19	5.69	0.07	1.67	1.04	2.67	0.034*
Frightened by the experience	13.58	10.08	17.08	<0.001*	10.59	4.49	24.98	<0.001*

*p-value < 0.05.

ASDS continuous score (see Supplement Tables 1 and 2). Predictors of the ASDS 53 cut-off were comparable, at the bivariate level, to those of the ASDS 56 cut-off.

4. Discussion

4.1. Prevalence of Probable ASD

The prevalence of probable DSM-5 ASD in this present sample exposed to the blast was 37.57% and the mean ASDS score was 48.76 ± 16.65. Though not completely comparable to other prevalence studies using the DSM-IV criteria, and keeping in mind that DSM-5 criteria yield a higher prevalence of ASD as compared to its predecessor (14% versus 8%; Bryant et al., 2015), this prevalence is relatively high compared to other studies (Bryant et al., 2011). When comparing it to similar traumata, it is higher than the one reported post-September 11, 2001 (12.30%; Holman et al., 2008), but a little lower than the prevalence of 46.70% reported after the Madrid terrorist attacks of March 11, 2004 (Muñoz, Crespo, Pérez-Santos, & Vázquez, 2005). Our findings show a much higher prevalence rate than the systematic review findings of Geoffrion et al. (2020) that ASD rates range from 14.1% for war-related trauma to 36.0% for interpersonal trauma. The mean ASDS score is higher than the one reported by Fuglsang et al. (2004) in traffic accident victims (35.79) or reported by Wang, Li, Shi, Zhang, and Shen (2010) in earthquake victims (31.22). The composition of the samples and the nature of how exposure is assessed across studies may account, in part, for these discrepancies.

Based on the observed sensitivity (85.64%) and specificity (93.21%), and the good agreement of 90% (kappa 0.79), the current data indicated that although

the 56 cut-off performed well in identifying a probable DSM-5 ASD 'diagnosis', a cut-off score of 53 was an even a better identifier of ASD, which is comparable to the previously reported cut off of the ASDS (Bryant et al., 2000). We were only aware of an adapted version of the ASDS that accommodates the DSM-5 criteria after the current study commenced, and so we note that the proposed cut-offs are made relative to a measure that was not specifically designed to match ASDS-5 symptoms in terms of exact wording (Bryant, 2016).

4.2. Predictors of probable ASD

In the multivariable analyses, place of residence, being severely or completely affected by the explosion, and seeing dead/mutilated bodies were significant predictors of probable ASD. In terms of predicting ASD severity, the death of a close one and moderate or severe personal injuries were significant predictors of increasing scores. CART analyses for probable DSM-5 ASD show that the highest risk groups were females who either experienced the death of a close one or who saw dead mutilated bodies; these risk factors have been identified in many previous studies of vulnerability for PTSD development (Green, Grace, Lindy, Gleser, & Leonard, 1990; Olff, 2017). After removing fear at the time of the explosion from the CART analysis, exposure to death (death of a close one and seeing dead/mutilated bodies) seemed to play a major role in predicting probable ASD, especially in females.

The consistent finding for exposure was that the total exposure scores (based on the weights and the number of events) predicted ASD (probable DSM-5 ASD and ASDS score). Accounting for the complexities of how different exposures occur within a general

traumatic event is difficult to capture with a standardized measure, and accordingly it is common practice to use a cumulative exposure score rather than focus on specific exposures that can occur within a traumatic event; this is a key issue because discrete dimensions of trauma exposure can differentially impact mental health outcomes (Karam et al., 1999; Rhodes et al., 2010; Wilker et al., 2015). Both measurements of scores (based on the weights and the number of events) were concordant in their relation to probable ASD and were very strongly correlated, which in some ways reflect a general finding of a study by Wilker et al. (2015) which found that the number of different traumatic events and frequency of traumatic events both predicted PTSD well. It is worth noting that exposure measures did not explain a high degree of the variance possibly because of the effect of the common exposure that all participants experienced. There is a need to develop more nuanced measures to assess the specific elements of trauma exposure that are associated with psychopathological responses.

Overall, younger age and female gender were predictors of ASD (probable ASD DSM-5, ASDS score, and ASDS 56 cut-off), consistent with other studies (Fuglsang et al., 2004; Jhangiani, 2010). Being a nurse as compared to being in the other non-clinical staff is the only profession that remained in the multivariate analyses a risk factor for ASD (probable ASD DSM-5 and ASDS score). This may be due to being at the frontline of exposure in their work (e.g. witnessing more mutilated bodies) and having more deaths of a close one. It should also be noted that nurses represented the largest group among respondents, and this may also have contributed to the finding.

Being frightened by the experience was consistently a highly significant factor predicting acute stress, explaining approximately 10% of the variance in ASDS scores, which accords with previous studies (Fuglsang et al., 2004). Further, a study of the World Mental Health survey ($N = 28,490$) found that the diagnosis of PTSD was higher in the presence of reported fear, horror, or helplessness at the time of trauma (9.7%) relative to when this is not considered (0.1%) (Karam et al., 2010). It appears that a similar pattern occurs in probable ASD, which was also confirmed by the CART analysis. We note that it is possible that feeling frightened by the experience could have served in our study as a proxy for other unmeasured factors such as genetic factors, predisposition to mental health disorders, presence of other past or present mental health disorders, and others.

4.3. Strengths and Limitations

In terms of the major strengths of this study, this baseline data from a longitudinal study that will consist of five waves of data is noteworthy because it occurred in the acute period after a very distinct potentially traumatic event insofar as the severity of the blast, the drastic economic backdrop to the blast, and the unfolding pandemic. Other strengths included the study's focus on DSM-IV and DSM-5 definitions of ASD, the collection of data in a naturalistic setting in the context of routine COVID-19 testing, as well as a much-neglected focus on health workers who are rarely studied in the aftermath of traumatic events.

In terms of limitations, this is a self-selected sample of hospital staff who presented voluntarily for PCR testing 9–15 days after the blast; accordingly, the sample may not be representative of all health workers. Relatedly, we could not generate the response rate, although we tried to mitigate this by adjusting for age, gender, profession, and other important specific exposure events. Another potential limitation is that we did not validate the probable DSM-5 ASD diagnosis using a structured clinical interview. Further, we did not assess a range of relevant key factors including the extent to which respondents 'felt' the explosion, social support, psychiatric history of mental health disorders, financial situation, and COVID-19 stressors (some of these issues will be addressed in subsequent waves of this study). Moreover, the baseline data which is used for this study were collected directly after the blast. It is important to note that the healthcare workers were also exposed to the COVID-19 pandemic and the catastrophic financial meltdown, and it is difficult in the current data to disentangle the effects of these different stressors. One of the strengths of this study is that it will allow ongoing modelling of the trajectories of the cumulative effects of the pandemic, blast, and economic plight of people in Beirut.

5. Conclusion

In summary, this study demonstrates that the acute aftermath of the Beirut Port Blast was associated with markedly high rates of probable ASD relative to rates reported in most other studies of populations following other types of traumatic events. Whereas most factors identified as increasing risk of probable ASD are consistent with those reported after other traumatic events, subsequent waves of this study will permit modelling of how factors related to the blast, pandemic, and financial stress in Lebanon contribute to longer-term trajectories of adjustment to these cumulative stressors.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

As this study is part of a larger longitudinal project the data cannot be made publicly available at this time.

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Appendix 1: Beirut Port Exposure Inventory

Q1: Where were you at the time of explosion?

1. Hospital
2. Home
3. Street
4. Other, specify:_____

Q2: Were you physically injured?

1. No
2. Mildly: superficial cuts and bruises
3. Moderately: fractures, etc …
4. Severe: potentially life threatening, needed hospitalization

Q3: If you were physically injured, did you have trouble getting the needed medical attention?

1. Yes
2. No
3. Not applicable

Q4: Did any of your close ones die?

1. Yes (please specify relation _____)
2. No

Q5: Was any of your close ones severely injured?

1. Yes (please specify relation _____)
2. No

Q6: Was any of your close ones injured moderately or mildly?

1. Yes (please specify relation _____)
2. No

Q7: Was the place where you live affected by the explosion?

1. No
2. Moderately (glass shattered, doors broken, etc …)
3. Severely (needs major work and inhabitable now)
4. Completely (complete or almost complete destruction)

Q8: Did you participate in rescue efforts of patients in the hospital or other injured people outside the hospital?

1. No
2. Yes, light injuries
3. Yes, moderate injuries
4. Yes, severe injuries

Q9: Did you see any mutilated / dead bodies?

1. Yes
2. No