RESEARCH ARTICLE

The association between the distance from the epicenter of the Haiti earthquake (2021) and medical diagnoses: A report from the field [version 1; peer review: awaiting peer review]

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Abstract

Background: Following the earthquake of August 2021 in Haiti, humanitarian agencies provided support to the local population. NATAN, a voluntary based non-governmental organization, had arrived in the field five days after the earthquake and provided medical support based on a mobile clinic in seven villages close to the epicenter of the earthquake.

Methods: We conducted a cross-sectional study on data collected from 331 persons of concern, as part of 'good clinical practice'. They received basic treatment such as antibiotics and minor surgical interventions following a diagnosis. The main variables that were collected in this intervention included demographic data, main diagnoses, and main treatments. We also examined the distance from the earthquake epicenter (DfE) and its effects on the diagnoses and treatments.

Results: Several interesting findings were observed. A significant association between the DfE and the diagnoses was found, where within the group closest to the epicenter, the most prevalent diagnosis was internal medicine problems (40.3%).

Conclusions: It is possible that since five days had passed since the earthquake, the expected diagnoses of traumatic injuries were reduced, leaving sub-acute problems to be diagnosed and treated. Finally, mental health symptoms and stress levels should be assessed systematically and with validated measures.

Keywords

Haiti, humanitarian action, earthquake, mobile clinic, epicenter

Open Peer Review

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Any reports and responses or comments on the article can be found at the end of the article.

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Introduction

On the morning of Saturday, August 14th, 2021, an earthquake struck Haiti. The epicenter of the earthquake was recorded 125 km west of Port-au-Prince, the capital of Haiti. The earthquake occurred in a depth of 10 km below the surface of the earth, at a magnitude of 7.2 on the Richter scale (PAHO, 2022). Following the earthquake, 2,246 people had died, more than 12,000 were wounded and about 650,000 people needed urgent humanitarian assistance (PAHO, 2022). The Haitian government appealed for emergency support, a call which was responded by the international community that included United Nations agencies as well as international non-governmental organisations (NGOs). The main support was obviously provided to the communities that were closer to the epicenter, as they were more affected and in line with previous studies (Balhara *et al*., 2018). The consequences were severe, especially following the previous and devastating 2010 earthquake in Haiti, which took the lives of approximately 220,000 people, with an injury rate of 40.2/1000 residents (Doocy *et al*., 2013). Beyond the urgent need to treat acute health problems (e.g., injuries, urgent surgeries), past experience with such missions have also pointed to the need to help with worsening of pre-earthquake chronic diseases (Millin *et al*., 2006; Worlton *et al*., 2022).

One of the NGOs that responded to the appeal was NATAN - Worldwide Disaster Relief, an Israeli voluntary NGO. Initially, NATAN sent an assessment delegation followed by a medical team (the authors of this study). The medical delegation included three physicians and a social worker. One of the physicians spoke French, the language which is understood by the local population. For further language barriers, the delegation relied on a translator. The medical team arrived a week after the earthquake and was working for six days. The team moved from village to village around the epicenter, operating a mobile clinic in collaboration with local physicians. The local clinics were often short of medications and equipment, and the arrival of the mobile clinic enabled the local physicians to invite to the relatively better equipped mobile clinic patients that could use their services. Based on past experience in previous humanitarian missions and in line with previous studies (Kligerman *et al*., 2017), the medical team prepared and provided medical response that met the needs following the earthquake. In several cases, patients were referred to hospitals for further treatment.

In this study we present and analyze data collected during this humanitarian mission. Furthermore, we examine if the distance from the epicenter (DfE) was related to the medical diagnoses. DfE was found to be a contributing factor to physical and mental morbidity following earthquakes. Cao *et al*. (2003) found large differences in the prevalence of mental health diagnoses as a function of the DfE following the Hunan 1998 earthquake, China. A shorter DfE could be associated with more severe physical injuries and higher stress, possibly resulting also in more psychiatric morbidity. We thus hypothesized that a smaller DfE will be related to worse health conditions.

Methods

Study design - This study followed the Strengthening the reporting of observational studies in epidemiology (STROBE) checklist. This was a cross-sectional study.

Ethics statement

Ethical approval for this research was granted retrospectively by the IRB committee of Tel-Hai College (Ethical board decision number 7-6-2022, dated from 28.7.2022) with a waiver for collecting consent forms. The waiver for consent was granted due to the fact that this research was not originally planned to be a formal research, rather the data was collected as part of good clinical practice (GCP) by the NATAN's staff. Importantly, the team did not collect the participants' names for this study and throughout the data collection, the anonymity of the patients was maintained at all times. Thus, not referring to individual cases or sharing data that could identify the patients, in line with the policy of NATAN.

The data collection and the publication of the research was part of "good clinical practice" aiming at consistent improvements and standardization of the humanitarian support provided. NATAN encourages research, evaluation and academic publication of its humanitarian efforts as part of its goals. Furthermore, NATAN aims at continuous improvements of its actions and missions, therefore the organization procedures includes monitoring and evaluation processes for internal professional learning. Moreover, the organization shares its experience and findings with the humanitarian sector in general, for the improvement of future humanitarian missions. The organization pursues academic publication subject to all the professional and ethical practices. Therefore, NATAN is aiming at publishing all relevant data that was collected for future humanitarian interventions and for further research purposes. The ethical definitions are in line with the definitions of the IRB committee. With this in mind, this research publication was approved by NATAN. In order to meet high standards of data collection and ethics, NATAN collaborates with Tel Hai college which performs as the academic institute supporting the organization monitoring and evaluation processes.

Sample

Three hundred thirty-one persons of concern (POCs) aged between 1 and 97, (mean: 30.9, SD: 25.1) years were examined by the NATAN team. Inclusion criteria included any person arriving at the local medical clinic, supported by NATAN's staff, inquiring medical assistance and communicating in French or Creole, thus this constituted a convenience sample. No formal pre-sample size calculation was performed. The sample included 45.9% men and 54.1% women. The clinical staff travelled every day from village to village based on information about the medical needs it received from the local partner (i.e. local medical governmental personnel operating in existing premises). The medical staff of the NGO assessed daily the needs through inquiring local agents about potential needs observed in villages and clinics around the earthquake epicenter.

Measures

The data collected included age, gender, medical treatment, diagnoses, and location. Using Google Maps and based on the names of the villages where the mobile clinic operated, we calculated the DfE in kilometers (PAHO, 2022), which was the exposure variable in the present study.

Outcomes

Diagnoses were based on a medical interview and evaluation (e.g. medical history intake, measuring BP, etc.) performed by physicians (M.A., S.S., Y.L.). The diagnoses were grouped into five main categories which included physical trauma, internal medicine, observed and reported mental symptoms (anxiety, insomnia or dizziness related to recalling the moment of the quake), infections and ObGyn as described in Table 1.

Treatment was grouped into four categories and included minor surgical interventions, GI (Gastrointestinal) medication, and symptomatic treatment (e.g. pain killers, antibiotics, anti-allergenic, anti-diarrhea).

The locations and the DfE of each clinic were as follows; Marceline (150 km), Solon (140 km), Duchity (50 km), Les Cayes (40 km), Plane Martin (40 km), La Hatte (20 km) and La porte (20 km).

Table 1. Sample characteristics: categorial variables.

Variable	Percent
Gender	
Male	45.9%
Women	54.1%
Diagnosis	
Trauma	20.6%
Internal	28.4%
Mental	11.9%
Infections	28.1%
ObGyn	11%
Treatment	
Surgery	3.5%
Symptoms	53.3%
GI Infections	20.1%
Antibiotics	23.1%
Distance from epicenter	
Up to 20 km	44.8%
Up to 40 km	37%
Up to 50 km	8.8%
Up to 140 km	3.3%
Up to 150 km	6.1%

We divided the DfE into three categories, to include groups of equal sizes as much as possible, as following: <40 km was defined as short DfE (n=81), 40 km was defined as medium DfE (n=67), and 50 km or more was defined as far DfE (n=33).

The statistical analysis included descriptive statistics and inferential statistics. The latter included an analysis of variance (ANOVA) and Chi square tests, to examine the associations between DfE and the main variables (age, gender, clinical diagnosis and treatment). We used version 27 of the SPSS software.

Results

As shown in Table 1, approximately half of the POCs were women (54.1%) and the other were men. One fifth were diagnosed with trauma (20.6%) and one third (28.4%) were diagnosed with internal medicine diseases, including infections. Half of the sample received symptomatic treatment (53.3%) such as pain relief or antiseptic treatment, and about one fifth received treatment for GI (gastrointestinal) symptoms (20.1%), such as anti-diarrhea medications. Finally, one third were prescribed and given antibiotics (23.1%). Nearly 45% were treated in a clinic that was 20 km from the epicenter, 37% were treated at a medium DfE and the rest (18%) were treated at clinics that from greater DfE. There were no missing data. For information on access to the raw data, please see *Underlying data.*

A strong U-shape association was found between age and DfE ($F(2,180)=19.25$, $p<0.001$), where POCs in the medium DfE were significantly younger (18.8 years) than the combined group of POCs in the closest and the most far DfE (39.76 years) ($t(178) = 5.8$, $p<0.0001$).

There was a significant association between the DfE and diagnoses (X^2 (8) = 29.62, $p<0.001$). Within the group closest to the epicenter, the most prevalent diagnosis was internal medicine diseases (40.3%). Within the medium DfE group, the most prevalent diagnosis was infections (41.9%) followed by internal diseases (27.4%).

Interestingly, approximately half of the trauma cases (50%), were more than 40 km from the epicenter, while the great majority of mental health cases were up to 40 km from the epicenter (81%). Similarly, an even greater majority of OgGyn cases were diagnosed up to 40 km from the epicenter (95.3%).

Women were significantly older (mean age = 34.7 years) than men (mean age=27.2 years; $t(325)=2.7$, $p=0.007$). No association between gender and DfE was found (X^2 (2) =0.7, $p>0.5$). No association was found between treatment and DfE (X^2 (6)=12.0, $p=0.06$). On the other hand, a significant association between gender and diagnosis was found (X^2 (4)=38.6, $p<0.0001$). These relations clearly stemmed from ObGyn including only women.

Discussion

The main and novel results in this study are the unequal distributions of diagnoses as a function of DfE. Surprisingly, unlike the expected observation of a physical trauma related to small DfE, ObGyn, mental disorders and internal medicine diagnoses were overrepresented in proximal DfE, compared to physical trauma. This is in line with past studies showing that several days after the index event, diagnoses of traumatic injuries related to the earthquake are declining (Chauhan & Chopra, 2017).

The poor medical system of Haiti before the earthquake and lack of medical services could be the reason behind the distribution of the health problems, and the effects of the earthquakes are exacerbated by these pre-conditions. Past studies show that improved infrastructure including internet and communication are factors in reducing risk (Anthony, 2011; Nagamatsu *et al*., 2011).

Nevertheless, the results observed in the present study could be explained in several ways. The most outstanding result is the relatively low prevalence of physical trauma, compared with higher rates of internal medicine problems and infectious diseases. First, unlike the major 2010 earthquake, the epicenter of 2021 earthquake was closer to rural areas characterized by wooden and small buildings. The type of buildings is a direct factor affecting the injuries, where poor structured buildings are more prone to collapse (Ellidokuz *et al*., 2005). Importantly, poverty as a sociological factor is leading to life in poor and underdeveloped conditions (Hu *et al*., 2011).

Another possible explanation might be that those who had physical trauma that resulted from the earthquake could not reach the clinic. Alternatively, because the clinic of NATAN arrived a week after the earthquake, those who had such trauma, may have already been treated (Chauhan & Chopra, 2017). Future humanitarian interventions operating more than a week after index events should be prepared to treat sub-acute diagnoses such as suture removal and percutaneous abscess drainage.

Furthermore, one could assume that the closer DfE may reflect a stronger stressor than farther DfE, and stress was found to be associated with physical trauma, internal medicine conditions such as myocardial infarction as well as with ObGyn problems and infectious diseases like the common cold (Meisel *et al*., 1991; Pedersen, 1998; Chi & Kloner, 2003; Khan *et al*., 2007; Traylor *et al*., 2020). A study done following the Hunan 1998 earthquake found a dose response relation between DfE and psychiatric problems, with a small DfE having 60.4%, medium DfE 48.2% and large DfE 44% psychiatric problems (Cao *et al*., 2003). Together these results suggest that stress related to DfE may be a risk factor for certain conditions treated following earthquakes. However, since stress was not assessed in the present study, such an explanation must be taken with caution. The high prevalence of infections may have also resulted from after-effects of the earthquake such as water systems breaking down, which could have increased the risk of infectious diseases (Chard *et al.*, 2018; He *et al.*, 2018).

The result which showed that POCs in the medium level were significantly younger than the combined group of POCs in the closest and the largest DfE, is difficult to explain. A reasonable explanation may be related to the timing in which the clinic operated in the medium level distance. The clinical service provided in the medium distance operated during the weekend, when the younger people are not at work or in other obligations.

Limitations and future directions

This report is based on data collected for good clinical practice, rather than for formal research. Hence, the sample was not representative and was relatively small. Furthermore, no formal pre-sample size calculation was performed. The basic diagnostic tools used in the clinic enabled the team to diagnose patients' illnesses only partly without precise and sophisticated laboratory measures. The dynamic nature of the NGO work, where the decision about which village to visit, was taken only a day before the visit, not enabling all the potential POCs to plan to visit the clinic. Moreover, data on living conditions and other co-morbidities were not known to the authors.

The options for follow up treatment for the POCs in local facilities and access to medications were limited. We could not identify the distance from the permanent local medical centers, thus the lack of such options affected the medical decisions of the physicians in relation to treatments.

Future medical interventions should follow the same method of outreach to communities, yet further outreach is required with home visits if possible. The home visits will enable the team to examine individuals that have no access to the clinic due to age, disabilities, physical concerns, or cultural barriers (e.g., women as the main caregivers). The interventions should be planned in advance and should include trainings (Yang *et al*., 2010; Li *et al*., 2017) in order to assure that as many POCs as possible can attend the clinic and should include standardized protocols and reports as instructed by the World Health Organization (WHO, 2023). Finally, future studies should assess patients' stress levels, using short visual analogue scales, to gauge at stress-related disorders.

Data availability

Underlying data

The raw data are not available on a repository due to NATAN's data sharing policy, which prohibits any raw data being shared publicly. The need to keep the patient privacy and anonymity is crucial, particularly where there data on their location has been collected. The anonymized data that support the findings of this study are available on request from the corresponding author (Einav Levy: levygaea@gmail.com). Interested readers should provide a clear reason for the access request, and the professional background of the person should be included. The data will be granted only for learning and research purposes, and only after reviewing the request in ethics committee of both NATAN and Tel Hai College.

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