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# Assessing the public health impacts of disasters: A retrospective study of the October 2015 Hindu Kush earthquake in Pakistan

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ABSTRACT

It is well-established that the rate of natural disasters has increased in the last three decades, with millions of people affected. The direct impacts of disasters, including earthquakes, have been monitored and documented; however, only limited information is available on the impact of natural disasters on healthcare institutions and communities. Even less information is available on the different ways in which aftereffects of these events are reflected in global and public health indicators. This study aims to assess and analyze earthquake-related public health impacts on communities and their health service-providing institutions. To this end, we conducted a case study of ten districts hit by the October 2015 Hindu Kush earthquake in Pakistan. We grouped these districts into two groups of five each: Group I include the districts most seriously affected by the earthquake in terms of death toll, number of injured and structural collapses; Group II includes the less-affected districts, which experienced lower mortality and injury rates and less structural damage than those in Group I. We retrieved six years of monthly data from the District Health Information System of the selected districts and analysed it to examine trends of ten indicators in pre- and post-earthquake contexts. Findings from both groups revealed that districts in Group I showed significant variation in trends relating to rates of communicable disease, e.g. tuberculosis and hepatitis C; of vector-borne diseases, e.g. malaria; and of psychological problems such as depression and anxiety. On the other hand, trends in indicators relating to health care services including antenatal care, immunization coverage, and postnatal care remained stable. It can be concluded that earthquakes does impact the health status and utilization of health service services within affected communities.

## 1. Introduction

Of the 1.35 million people killed by natural disasters over the past twenty years, more than half died in earthquakes [1]. The number of empirical studies that have validated why, and to what extent, certain groups of people are more vulnerable than others during disasters is exceedingly limited, especially in the domain of public health [2]. A series of well-publicized disasters in the early 1970s triggered the scientific interest of the public health community [3]. These studies emphasized elderly people, pregnant women, children under the age of five years, and people with disabilities, as they were considered the most vulnerable populations; until recently, though, no concrete evidence has been presented to validate such assumptions [4,5].

Even though a limited number of epidemiological studies are available, it is a well-established fact that the impact of earthquakes increases exponentially if they co-occur with a disease outbreak [6]. When an earthquake hits any part of the world, inhabitants of that area are affected regardless of sex, age, economic standing, or social status [7]; however, the highest mortality and morbidity rates often belong to specific population groups: the poor, women, children, the elderly, people with disabilities, etc. [8,9]. In addition, the devastating impacts of earthquakes of the same magnitude and intensity may be very different when they occur in developing rather than developed countries [9]. In the past, such disasters have resulted in massive social disruption, widespread death, and outbreaks of epidemic disease [10], causing communities to be paralyzed and survivors to be completely dependent on outside aid.

The 2030 agenda for Sustainable Development Goals (SDGs) and the 2015–2030 Sendai Framework for Disaster Risk Reduction (Sendai Framework) both intend to reduce the number of lives lost and minimize human suffering from natural disasters across the globe [11,12]. This will be possible only if Disaster Risk Reduction (DRR), Public

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Health Interventions (PHI) and SDGs are fully aligned [13,14]. The integration of DRR, PHI and SDGs will only be possible if the linkage between disaster and public health impacts is understood. To this end, a number of epidemiological studies have been conducted in different fields of science; the subjects of the majority of these studies investigated communicable and non-communicable diseases in various contexts, i.e. environment, water, sanitation, and hygiene [15–17]. Only a limited number of studies, though, have been undertaken to study natural disasters from a public health perspective [2].

## 2. Methodology

### 2.1. Study objective

This study seeks to assess public health risks and vulnerabilities in the aftermath of an earthquake. The objective is to understand the variation in trends of prevailing public health risk in terms of communicable diseases (tuberculosis, hepatitis C), vector-borne diseases (malaria), infectious diseases (trachoma), and health service coverage (antenatal and postal-natal care, immunization coverage).

### 2.2. Study area

This study is focused on the Hindu Kush earthquake of October 2015 in Khyber Pakhtunkhwa (KPK), Pakistan. KPK is a province comprised of twenty-six districts in the north-west of Pakistan. As of the time of this publication, the 2015 earthquake was the most recent major earthquake in the area. According to the United States Geological Survey (USGS) [18], this earthquake had an epicentre located forty-five km southwest of Jarm and about sixty-seven km northwest of the Chitral district in Pakistan. It was initially assigned a magnitude of 7.7, though this was later revised to 7.5 by the USGS [18]. The deadliest earthquake in the history of Pakistan hit the same area in 2005, resulting in 85-thousand-plus deaths, and the most devastating earthquake in South Asia in recorded history [19]. The study area is the highly vulnerable to major earthquakes because of its geological features: The Main Karakoram Thrust (MKT), Main Mantle Thrust (MMT), and Main Boundary Thrust (MBT) [19].

### 2.3. Study design and data source

For this retrospective study we selected ten districts in an area that is highly vulnerable to earthquakes. These ten districts were then separated into two groups, each containing five districts (Fig. 1 and Table 1a). The demographic profile of selected districts can be seen in Table 1b. The District Health Information System (DHIS), managed by the provincial government, was used to retrieve data about selected health indicators (The selected indicators are shown in Table 2) at pre- and post-earthquake intervals. Information contained in the database was entered by specially trained staff in healthcare facilities. The DHIS covers all twenty-six districts of the province, and reporting compliance within the study area was found to be 100% [20].

### 2.4. Indicators and data

The WHO uses one hundred indicators to monitor health and wellbeing across the world [22]. We purposely selected ten indicators closely linked to the objectives of the study for consideration (Table 2). We used monthly prevalence and incidence trends reported by public health facilities to avoid, or at least minimize, the effects of bias within the study.

## 3. Results

### 3.1. Maternal health and visits to Antenatal Care (ANC) facilities

According to Glynn et al. [23], while earthquakes potentially present a significant public health risk to pregnant women, this effect is not usually realized due to humanitarian services that bring antenatal clinics closer to women, increasing the number likely to utilize antenatal care (ANC) services. Categorically similar to the findings reported by Glynn et al. [23], in the districts of Group I (most severely affected by the earthquake), the baseline monthly number of women attending the antenatal clinic in January 2011 was 3718; from that year to 2016, there was a slow, but steady, increase in the number of women visiting the antenatal clinics (Fig. 2). In October 2015, when the earthquake occurred, 5098 women visited ANC; this number, however, cannot be definitively attributed to the earthquake, as the rate continued to rise slowly after the event, with the trend continuing into 2016. Hence, the earthquake did not significantly affect the rate of ANC visits by those living the affected region. Among those living in Group II districts, the trend in ANC is similar to the first group; visits increased steadily from 2011 to 2016, uninterrupted in any way by the disaster. A similar trend is also seen among women who attended ANC for the first time in both regions of the study. It is, therefore, apparent that the earthquake did not create any major interruption in this critical public health service.

### 3.2. Child health and immunization

Monthly trends related to the immunization status of children are shown in Fig. 3. During the baseline year 2011, only 3000 children residing in the districts of Group II were fully immunized at twelve months. Other than small fluctuations, the overall trajectory rose steadily toward 2016; however, in August 2012, there was a great decline in the number of fully immunized children, though the trend of increasing vaccination resumed within a month. The rate of full immunization dropped significantly again in October 2015, likely due to interruption of regular health services in the aftermath of the earthquake. After the low prevalence of full immunization during that October, though, the rate picked up again, albeit at a very slow pace, then plateaus during the year from November 2015–2016. Grais et al. [24] explains that, on the one hand, humanitarian services in earthquake-stricken areas usually shields the victims from experiencing the full effect of the disaster, as they provide many necessary services, such as routine immunizations for children. On the other hand, the baseline immunization rate (from 2011) in the area hit severely by the earthquake was relatively high, as more than ten thousand children received full immunization. The prevalence of immunization increased dramatically in the following months to about twenty thousand children. Starting from January 2013, though, the rate dropped to almost to that of the baseline year, with occasional fluctuations before stagnating until November 2016 when it dropped to its lowest-ever rate in the region. It did, in more recent years, rise again, but the earthquake cannot be associated with these constant fluctuations in immunization rates.

### 3.3. Infection by trachoma

Monthly trends in the number of cases of trachoma are shown in Fig. 4. The earthquake-affected districts of Group I enjoyed an extremely low prevalence of trachoma infections from January 2011 on, with a baseline rate of twenty-six cases per month; however, during January 2014, there was an epidemic, evidenced by the sharp rise in reports of cases from a low of forty-eight cases per month to about 1200 cases per month. The epidemic was apparently unrelenting, as the rate of new infections remained high through 2014, 2015, and 2016, with no significant change during the earthquake period in 2015. Thus, it seems that the earthquake had no role in the increase in trachoma cases

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