sustainability

MDPI

Article

Using Logistic Regression to Identify Leading Factors to Prepare for an Earthquake Emergency during Daytime and Nighttime: The Case of Mass Earthquake Drills

Jaime Santos-Reyes

Grupo de Investigación, SARACS, SEPI-ESIME, ZAC, Instituto Politécnico Nacional, Mexico City 07738, Mexico; jsantosr@ipn.mx

Received: 15 November 2020; Accepted: 27 November 2020; Published: 30 November 2020

Abstract: Historical data have demonstrated that earthquakes can happen any time of the day and night. Drills may help communities to better prepare for such emergencies. A cross-sectional survey was conducted from 4 October to 20 November 2017, in Mexico City. The sample size was 2400. The addressed research questions were "what factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills: (a) any time of the day and (b) any time at night?" The logistic regression technique was employed to identify the factors leading to the outcome. In relation to (a), five variables were significantly associated with the outcome, i.e., age, frequency of drills, warning time, knowledge on what to do, and "perception vulnerability city". Regarding (b), five variables were also significantly associated with the outcome variable, i.e., age, level of education, frequency of drills, negative emotions, and fear of house/building collapsing. More generally, several drills should be conducted any time of the day and night; further, 50% of them should be announced and 50% unannounced. Furthermore, the time of earthquake drills should be randomly selected. In this way, we may just match the spatial–temporal dimension of an earthquake emergency. It is hoped that the findings will lead to better preparedness of the residents of the capital city during an earthquake occurrence.

Keywords: earthquake drills; daytime drills; nighttime drills; earthquake emergency; logistic regression; SASMEX

1. Introduction

There is not a single day without news on disasters in the mass media recently. It appears that governmental organizations are all aware of the importance of preparing for mass emergencies, for example, the Federal Emergency Management Agency's mantra "prepare, plan, be informed" [1] and similar governmental and international agencies' safety policies worldwide [2–7]. However, recent events (e.g., earthquakes, tsunamis, volcanic eruptions, COVID-19) have demonstrated the lack of preparedness to such events [8–15], to mention just a few.

Drills (or exercises) may be regarded as key activities that may help to educate communities about what actions to take during an earthquake occurrence and what procedures to follow during an evacuation, among other things. Drills also aid in assessing the effectiveness of an emergency response plan [16–19]. Further, they contribute to the process of identifying, for example, gaps, flaws, and shortfalls of safety policies and evacuation procedures. Furthermore, a drill can also be an effective method for training all of those involved in conducting the exercises [16,17].

1.1. Daytime Drills and Earthquakes

In preparing for an emergency due to an unexpected earthquake, drills play a key role in such a process; however, there is evidence of earthquake drills being conducted at a fixed date and time [20,21]. This prompts the question as to whether they are effective. Further, there is also plenty of evidence that earthquakes have occurred at varying times during the day; these events have had devastating consequences in terms of life, property, and economic loss, among other things (Table 1).

A number of reports have been published in the literature on daytime drills in different types of organizations and hazards, for example, terrorism incidents [22], technological systems [23–25], health related systems [26,27], the armed forces [28], earthquakes [18,19,29], and other [30]. However, there is no evidence of studies being conducted on mass earthquake drills at any time during the day, but only at a fixed date.

Table 1. Some examples of earthquakes occurring at different times during the day [a].

Date	City/Region/ Country	Time [b]	Size	Consequences/Impact
26 December 2004	Indian Tsunami/Sumatra-Andaman Earthquake, Indonesia.	07:58 a.m.	M9.3	Over 220,000 people were killed or missing, and about 1.7 million were displaced in South Asia and East Africa because of the earthquake and tsunami [31].
1 September 1923	The Great Kantó, Earthquake, Japan.	11.58 a.m.	M7.9	Total of deaths and missing persons was more than 100,000 and more than 460,000 destroyed homes [32].
8 October 2005	Pakistan/Kashmir Earthquake, Pakistan	08.50 a.m.	M7.6	Over 87,000 people were killed, 138,000 missing, and over 3.5 million were rendered homeless [33].
22 February 2011	Christchurch Earthquake, New Zealand.	12.51 p.m.	M6.1	About 80,000 houses were significantly damaged, 185 lives were lost [34].
25 April 2015	Nepal Earthquake, Nepal.	11.56 a.m.	M7.8	Over 8,700 people were killed, 22,300 injured, over 790,000 houses were significantly damaged [35].
12 January 2010	Haiti Earthquake, Haiti.	16.53 p.m.	M7.0	Over 222,000 lives were lost, over 300,000 injured and over 1.5 million displaced [36].
12 May 2008	Sichuan Earthquake, China.	14.28 p.m.	M8.0	69,227 people were killed, 17,923 missing, 373,583 were injured [37].
23 June 2001	Southern Peru Earthquake, Peru.	15.33 p.m.	M8.4	About 130 fatalities, 21,000 were displaced, about 15,000 dwellings were destroyed [38].
19 September 2017	Puebla Earthquake, Mexico.	13.14 p.m.	M7.1	It left 370 people dead, over 6000 injured, and hundreds of damaged buildings in the capital city [39].
19 September 1985	Mexico City Earthquake, Mexico.	07.17 a.m.	M8.0	It killed about 40,000 people, 30,000 destroyed homes, 68,000 damaged houses [40].
15 October 2013	Bohol Earthquake, Philippines.	08.12 a.m.	M7.2	Over 200 were killed, 976 injured, over 348,000 were displaced [41].
11 March 2011	Tohoku Earthquake, & Tsunami, Japan.	14.46 p.m.	M9.0	Over 19,000 were killed, over 6200 injured, 2,569 missing, 121,781 totally collapsed buildings, 744,530 partially collapsed buildings, 106, 592 uninhabitable houses [42].

[a] The selection criteria was based on earthquake occurrence at different times during the day and listed not in a particular order. [b] Given the purpose of our study, the time shown is the "local time" of earthquake occurrence and not the UTC time that is usually reported by the international news agencies.

1.2. Nighttime Drills and Earthquakes

In relation to the 1906 San Francisco earthquake, US, a nurse related her experience on the event: "The first vibration at 5:13 am, on the 18th day of April, awoke me. Without conscious volition I jumped from my couch and stood gasping audibly as I was shaken by the long vibrations…" [43]. More recently, and in relation to the 7 September 2017 earthquake in Mexico (which occurred at 23:49 pm., local time), a resident of the capital city was asked about her experience; she said this: "What I felt was that my bed moved, but I didn't hear anything (i.e., the seismic alarm), I do not know if I was already asleep or it didn't sound (the seismic alarm)" She was still confused by the earthquake [44]; however, the seismic alarm went-off 90 seconds before the actual ground shaking [20]. Effectively, experiencing earthquakes at night is not the same as experiencing one during daylight. In fact, it may be argued that sleep may constitute an important risk factor, among others, for earthquake death.

Therefore, in preparing for an emergency, drills (or exercises) should aim at educating building/home occupants as to the adequate actions to take during the emergency [2,17,22].

Some reports have been published in the literature on fire drills at night, in particular for the cases of health centers [45–47], student accommodation at university campuses [48], hotels [49,50], fire fighters [51], and in the military [52]. In most of the cases (except for the military), night fire drills are required by fire safety regulations, codes of practice, etc., that these organizations should comply with. Nevertheless, there are hardly any report on earthquake drills being conducted at night. Again, this prompts the question whether they may be necessary. However, there is plenty of evidence that earthquakes have occurred at night and with devastating consequences in terms of life/property/economic loss, among other things (Table 2).

Table 2. Some examples of earthquakes that have occurred at night [a].

Date	City/Region/Country	Time [b]	Size	Consequences/Impact
17 January 1994	Northridge Earthquake California, US	04.31 a.m.	M6.7	It is believed that over 70 people died and 11,800 were injured and 60,000 houses and apartments were damaged [53].
27 February 2010	2010 Chile earthquake, Chile	03:34 a.m.	M8.8	Over 500 people were killed, about 2 million people were affected by the earthquake and tsunami [54,55].
6 April 2009	L'Aquila earthquake, Italy	03.32 a.m.	M6.3	Over 67,000 people were left homeless, 309 killed, 1550 injured, and about 10,000 damaged buildings [56].
26 December 2003	Bam earthquake, Iran	05:26 a.m.	M6.7	Over 45,000 people were killed, 30,000 injured, 80% of the buildings collapsed, several villages were destroyed [57].
17 January 1995	Kobe earthquake, Japan	05:46 a.m.	M6.9	The death and missing toll stand at 6437 people; over 8,000 people required hospitalization, over 100,000 houses were destroyed, and over 140,000 houses were partially destroyed [58].
17 August 1999	Marmara earthquake, Turkey	03:01 a.m.	M7.6	Over 17,000 people killed, 35,000 injured, and about 600,000 homeless [59].
23 December 1972	Nicaragua earthquake, Nicaragua	00:29 a.m.	M6.3	It caused the death of 10,000–11,000 people; 20,000 injured, and 300,000 were left homeless [60,61].
21 September 1999	Chi-Chi earthquake, Taiwan	01:47 a.m.	M7.6	The death toll was 2492, over 51,000 collapsed buildings, and over 53,000 severely damaged buildings [62].
21 May 2003	Boumerdes earthquake, Algeria	19.44 p.m.	M6.8	The earthquake claimed 2271 lives, 10,000 injured, about 20,000 destroyed houses, and 160,000 people were left homeless [63].
7 September 2017	The Chiapas earthquake, Mexico	23:49 p.m.	M8.2	Over 100 people were killed, over 2 million people were affected [20].

27 May 1995	Neftegorst earthquake, Sakhalin, Russia	01:04 a.m.	M7.1	Over 1900 people were killed, and 750 were left injured [64].

[a] The selection criteria was based on earthquake occurrence at different times during the night and listed in no particular order. [b] Given the purpose of our study, the time shown is the "local time" of earthquake occurrence and not the UTC time.

According to Greer [5], the Japanese seismologists have already identified the future seismic risk threat to the country; it is believed that the earthquake was already named over thirty years ago: "the Great Tokai earthquake". Further, it is argued that, if this earthquake were to hit the country in the middle of the night and without warning, it has been predicted that the death toll would be 7900 to 9200, and the damage cost up to US310 billion [5] (p.121). This clearly indicates that Japan is already preparing for one of the worst scenarios, that is, by creating the "Tokai Earthquake Preparedness Center" to map the risk associated with it and to build a resilient community [5] (p.121).

Following the two 2017 earthquakes that hit the capital city (on 7 and 19 September; see Tables 1 and 2), a research project on earthquake drills was envisaged, among other issues [20,39,65]. More specifically, the following three research questions needed to be addressed [20]:

1. What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills on September 19 yearly?
2. What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills anytime during the day?
3. What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills anytime at night?

The results of the first question has been addressed in [20]; the present paper addresses the second and third research questions. The logistic regression method has been employed to the identification of the factors leading to the outcome variables.

The paper is organized as follows: Section 2 briefly describes the materials and methods employed in the analysis. Section 3 presents the main results of the analysis. Section 4 presents the discussion of the main findings related to the second research question. Section 5, on the other hand, presents a discussion of the main findings related to the third research question. A summary of the identified leading factors to the outcome when considering the three research questions is presented in Section 6. Some of the limitations of the study are discussed in Section 7. Finally, some conclusions are summarized in Section 8.

2. Materials and Methods

A cross-sectional study was conducted in the capital city in 2017 following the two earthquakes (i.e., on 7 and 19 September, see Tables 1 and 2). The questionnaire was designed to assess several issues related to the residents' perception on the usefulness of the earthquake early warning system [20] and residents' reactions to the 2017 earthquake [65], among others, that are still being processed. As mentioned in the introduction section, the capital city's residents perception of conducting drills anytime during the night and daylight are addressed herein. The survey was conducted from 4 October to 20 November 2017, and the sample size was N = 2400. As mentioned in [39], all the participants of the study completed the questionnaires anonymously and were assured of the confidentiality of their answers. Further, they were given the contact details of the researchers. Furthermore, the survey was approved by the ethics committee, further details are given in Refs. [20,39].

2.1. Variables

2.1.1. The Outcome Variables

The outcome variables were related to whether the participants of the study agreed on conducting mass earthquake drills any time during daytime and nighttime. That is, "Would you like mass evacuation drills to be conducted at any time of the day?" The participants of the study rated their answers according to the following options: "Yes" or "No". (Hereafter, they will be referred to as either mass evacuation drills anytime during daylight or daytime drills). Similarly, "Would you like mass evacuation drills to be conducted at any time of the night?" As with the previous case, the answers to the question were "Yes" or "No". (Hereafter, they will be referred to as either mass evacuation drills any time at night or nighttime drills).

2.1.2. Explanatory Variables

A total of nineteen explanatory variables were considered in the analysis and summarized in Table 3. A brief description of each of them is given in the subsequent paragraphs. A detailed explanation of each of the explanatory variables and the employed questionnaire are given in "Appendix A-supplementary data" in the study by Santos-Reyes [20]. It should be highlighted that regarding categorical variables, dummy variables were created to conduct the analysis.

Table 3. Summary of explanatory variables considered in the analysis.

Categories	Variables	Type of Variable and Measures
Demographics	1–4. Age, sex, educational level, and occupation.	Modelled as categorical variables; however, age was modelled as a continuous variable for the case of "daytime" drills (Section 3.1). In some instances, variables collapsed into two levels (e.g., age (nighttime drills, Section 3.2), occupation, educational level. etc.).
Location	5. Participants home location.	"CDMX" (Mexico City) and "EDOMEX" (Metropolitan area of the capital city) and modelled as categorical variables.
Earthquake experience	6. 1985 earthquake experience.	This variable was related specifically to whether respondents experienced directly the 1985 earthquake; modelled as categorical variable: "Yes"/"No".
Earthquake knowledge	7. Knowing what to do. 8. Current knowledge. 9. Knowledge vs. drills	Knowledge on what to do (actions to take during the ground shaking) once the seismic alert goes off. Categorical variable: "Yes"/"No". Knowledge on the current situation on seismic risk in relation to Mexico City and modelled as a continuous variable. Having good knowledge on what to do during an earthquake; drills may not be necessary; categorical variable: "Yes"/"No".
Earthquake Drills	10. Participation in drills. 11. Frequency of drills.	Related to having participated in drills before (at home, school, any organization) and modelled as categorical variable: "Yes"/"No". Categorical variable with seven groups: "0/year", "1/year", "2/year", "4/year", "6/year" and "12/year".
The SASMEX	12. Warning time. 13. Usefulness of the SASMEX.	The time elapsed between the beginning of the seismic alert and the actual ground shaking [66]. Categorical variable: "Time varies"/"Other". Participants assessed the performance of the SASMEX during the 19 September 2017 earthquake. (For further details of the SASMEX (Mexican Seismic Alert System) in the context of the 2017 earthquakes [39]); categorical variable: "Very useful"/"Not at all".

Perception of seismic risk	14. Likelihood of harm. 15. Severity of harm. 16. "Perception vulnerability city" (PVC).	Risk judgement includes a person's estimate of the likelihood of harm to self and his/her perception of the potential severity of that harm [67]. Both modelled as continuous variables. Two items were combined into a compound measure called "Perception vulnerability city" (PVC). Modelled as a continuous variable (α = 0.67).
Psychological reactions	17. Negative emotions. 18. Fear of Sept. 7 and 19 earthquakes. 19. Fear house collapsing during Sept. 7 and 19 earthquakes	Research has shown that negative emotions (e.g., worry, anger) could at times directly drive information seeking [67,68]. Five items were considered to measure it and modelled as a continuous variable (α = 0.75). The level of fear of 7 and 19 September 2017 earthquakes experienced by the participants. Categorical variable: "A lot"/"Not at all". The fear homes/buildings collapsing during the earthquake occurrence. Categorical variable: "A lot"/"Not at all".

Demographic characteristics. The demographic variables considered in the study were sex, age (Range: 13–65 years old; M = 34.5, SD = 345.67), educational level (primary/secondary, high school, undergraduate and postgraduate), and occupation (students, education sector employees (ESE employees), private and public employees (P&P Employees), and other (retirees, etc.)).

Earthquake experience. This variable was related specifically to whether respondents directly experienced the 1985 earthquake (for a discussion on "direct" and "indirect" experience on natural hazards, see for example [69,70].

2.2. Statistical Analysis

The collected data were analyzed by using the SPSS 25.0 (Statistical Package for the Social Sciences software, NY, USA). Descriptive analysis was conducted by frequency and cross-tabulation analyses. The mean and standard deviation of continuous variables were calculated; means were compared using the independent t-test (Table 4). Some variables with four levels were collapsed into two. As mentioned in Table 3, some discrete items were transformed into a continuous variable by reporting the relevant Cronbach's alpha of internal consistency. Further, continuous variables were centered to the mean before entering the multivariable analysis; this contributes to the removal of non-essential multicollinearity; centering renders the regression coefficients in a regression equation meaningful (or more easy to interpret) [71].

When a dependent variable is dichotomous, such as in the present case study (i.e., agree on drills vs disagree), logistic regression, as opposed to discriminant analysis, is particularly appropriate [72]. Further, logistic regression analysis can be used to determine, for example, which explanatory variables and interactions contribute significantly to the outcome variable. The approach employed in the logistic regression analysis has been the purposeful selection of variables [72]. Overall, the algorithm embraces the following stages: (a) a univariable analysis is carried out to fit a logistic regression model for each variable; (b) a multivariable model is then fitted with all the explanatory variables (or covariates) that were significant in the first step at $p < 0.25$; variables that do not contribute at traditional levels of significance, or in the change of estimate criteria, are dropped in a stepwise manner; these two criteria are assessed iteratively; (c) those variables that were not considered in the first stage (i.e., $p > 0.25$) are then re-entered one by one and assessed at traditional significance (e.g., $p < 0.05$); and (d). Finally, the possibility of interactions among the explanatory variables in the main effect model is then assessed.

Table 4. Descriptive analysis of the explanatory variables considered in the analysis—daytime drills.

	Value Levels			**Mass Evacuation Drills any Time at Daytime? ***		
				Yes	**No**	**Total ****
				***n* (%)**	***n* (%)**	***n* (%)**
		Demographics:				
Sex	Men	936 (44.2)	131 (49.4)	1067 (44.8)		
Women	1183 (55.8)	134 (50.6)	1317 (55.2)			
Education level	Prim/Sec. School	171 (8.1)	36 (13.6)	207 (8.7)		
High School	1307 (61.7)	171 (64.5)	1478 (61.9)			
Undergraduate		495 (23.4)	45 (17.0)	540 (22.7)		
Postgraduate	146 (6.9)	13 (4.9)	159 (6.7)			
Occupation	Students	896 (42.3)	127 (47.9)	1023 (42.9)		
Employees	1223 (57.7)	138 (52.1)	1361 (57.1)			
		Location:				
Participants location	CDMX	1448 (68.3)	182 (68.7)	1630 (68.4)		
EDOMX	671 (31.7)	83 (31.3)	754 (31.6)			
		Earthquake experience:				
1985 earthquake experience	Yes	649 (30.7)	57 (21.7)	706 (29.7)		
No	1466 (69.3)	206 (78.3)	1672 (70.3)			
		Earthquake Drills:				
Drill past participation	Yes	1963 (93.0)	236 (89.4)	2199 (92.6)		
No	148 (7.0)	28 (10.6)	176 (7.4)			
Frequency of drills	0/year	49 (2.3)	50 (19.5)	99 (4.2)		
1/year	241 (11.5)	62 (24.2)	303 (12.9)			
2/year	143 (6.8)	23 (9.0)		166 (7.1)		
3/year	48 (2.3)		8 (3.1)		56 (2.4)	
4/year	89 (4.3)		4 (1.6)		93 (4.0)	
6/year	608 (29.1)	54 (21.1)	662 (28.2)			
12/year	911 (43.6)	55 (21.5)	966 (41.2)			
		The SASMEX:				
Knowledge warning time	Time varies	466 (22.0)		79 (29.8)	545 (22.9)	
Other				1653 (78.0)	186 (70.2)	1839 (77.1)
Usefulness SASMEX	Useful	303 (14.3)		40 (15.1)	343 (50.4)	
	Not at all	1815 (85.7)		225 (84.9)	2040 (85.6)	
Earthquake knowledge:						
Knowledge of what to do	Yes	1664 (78.5)		187 (70.6)	1851 (77.6)	
	No	455 (21.5)		78 (29.4)	533 (22.4)	
Knowledge vs. drills	Yes	1301 (61.6)		169 (65.0)	1470 (62.0)	
	No	810 (38.4)		91 (35.0)	901 (38.0)	
Psychological reactions:						
Fear of home collapsing	A lot	1449 (68.4)			158 (59.6)	1607 (67.4)
	Not at all	670 (31.6)			107 (40.4)	777 (32.6)
Fear of Sept. 15 earthquake	A lot	1539 (73.3)			166 (64.1)	1705 (72.3)

	Not at all	561 (26.7)			93 (35.9)	1254 (27.7)
Continuous variables	*Mean (SD)*	*Mean (SD)*			*p*	
		Perception of seismic risk:				
Likelihood of harm	Scale (0–10)	6.00 (2.27)	5.79 (2.16)	0.159		
Severity of the harm	Scale (0–10)	7.07 (2.16)	6.71 (2.07)	0.010		
Perception vulnerability city	(α = 0.75)	4.13 (0.817)	3.90 (1.02)	< 0.001		
Age [a]	Continuous	30.7 (12.6)	27.6 (12.1)	< 0.001		
Current knowledge [b]	Scale (0–10)	5.97 (1.99)	5.94 (1.95)	0.806		
Negative emotions [c]	(α = 0.67)	3.06 (0.885)	2.82 (0.934)	< 0.001		

* Total percentages in columns may not add up to 100% because of decimal rounding. (Only data within the outcome variable (column) is given). ** Differences in total n = 2400 are due to missing values in items. [a] Variable within the category of demographics. [b] Variable within the category of earthquake knowledge. [c] Variable within the category of psychological reactions.

3. Results

3.1. Results Related to Daytime Drills

The Multivariable Model

The frequency data regarding the dependent variable (i.e., evacuation drills anytime during the day) showed that 88.9% of respondents responded “Yes” and 11.1% responded “No” to the question. (Table 4 shows the results of a descriptive analysis of the explanatory variables considered in the analysis). Table 5 shows, on the other hand, the results of the univariable analysis when considering all the explanatory variables considered initially in the analysis.

Table 6 shows the final model (Model 2), which embraces the five contributing variables to the outcome, that is (a) age (demographics), (b) frequency of drills (earthquake drills), (c) warning time (The SASMEX), (d) knowledge of what to do (earthquake knowledge), and (e) the perception vulnerability city (PVC) (psychological reactions). Only the variable related to frequency of drills was the most influential to the dependent variable considered in the analysis (Wald: $\chi^2(6) = 100.945$, $p < 0.001$).

Regarding the variable age of the respondents, it has been found that for every additional year of age, the odds of agreeing on conducting daytime drills anytime increase by 1.5% (95% CI 1.003–1.027).

As mentioned above, frequency of drills was the most influential variable that contributed to the outcome. The results show that respondents that considered the frequency of “12 drills/year” have 15.106 times the odds of conducting daytime drills compared to those who considered none per year ($p < 0.001$, 95% CI 9.282–24.583). Similarly, those that considered “3/year”, “4/year”, or “6/year” have 5.575, 18.555, and 10.628 times the odds of conducting any time daylight drills compared to those who considered none ($p < 0.001$, 95% CI 2.371–13.107; $p < 0.001$, 95% CI 6.278–54.839; $p < 0.001$, 95% CI 6.509–17.353, respectively). In general, it may be argued that respondents of the study agreed to conduct several earthquake mass evacuation drills per year and at any time during the day.

Earthquake early warning systems (such as the SASMEX) are crucial in any seismic emergency; however, if they fail to perform their intended function (i.e., to timely alert people), individuals are not able to take cover (or evacuate in time). That is, warning time may be defined as the time elapsed between the beginning of the seismic alert and the actual ground shaking (it is also known as “prevention time” [66]). The results showed that respondents that considered the warning time as “other” have 1.478 times the odds of agreeing on conducting day-time drills compared to those that consider the ‘time varies’ (95% CI 1.091–2.004).

In any seismic emergency, it is of vital importance to knowing what actions should be taken during the occurrence of an earthquake; in the context of our case study, knowing what to do once the seismic alarm goes off is crucial in surviving an earthquake. The results show that respondents that considered having the adequate knowledge on what to do during the emergency have 1.413 times the odds of agreeing on conducting daytime drills compared to those that considered not having that knowledge (95% CI 1.034–1.932).

In relation to the variable related to the "perception of vulnerability of the capital city" (PVC), the results show that for every additional unit increase of perception vulnerability of the city, the odds of agreeing to conduct daytime drills increase by 21.6% (95% CI 1.041–1.420).

As mentioned in the "statistical analysis" section, the last stage of the employed approach to the logistic regression analysis was that related to interaction terms. A two-way approach to interaction terms was considered in the present analysis. However, when conducting such analysis, none of the considered interaction terms contributed to the outcome. In a similar study (i.e., when addressing the first research question, see the introduction section), it has been found that the interaction term "Occupation x PVC" contributed to the outcome variable [20]. However, in our present case study, when considering the demographic variable "Age x PVC", the effect on the dependent variable was not significant (Wald: $\chi^2(1) = 2.816$, $p = 0.096$).

Table 5. Results of the univariable analysis of the explanatory variables—daytime drills.

Value Levels	**OR [95% CI]**	***p***	
	"1" **		
	Demographic characteristics:		
Sex	Men	0.809 [0.627–1.045]	0.105 *
Women	1		
Age	Continuous	1.022 [1.131–2.654]	< 0.001 *
Education level*			
Postgraduate	2.364 [1.208–4.628]	0.012	
Undergraduate		2.316 [1.445–3.711]	< 0.001
High School	1.609 [1.086–2.384]	0.018	
Elementary School	1		
Occupation			
Other (Jubilee, etc.)	0.826 [0.574–1.188]		0.013 *
ESE Employee	1.539 [0.863–2.743]		0.144 *
P&P Employee	1.459 [1.084–1.965]		0.302
Students			1
	Location:		
Participants location	CDMX	1.016 [0.772–1.338]	0.909
EDOMX	1		
	Earthquake experience:		
1985 earthquake experience	Yes	1.600 [1.176–2.176]	0.003 *
No	1		
	Earthquake Drills:		
Drill past participation	Yes	1.574 [1.028–2.409]	0.037 *
No	1		
Frequency of drills *			
12/year	16.902 [10.471–27.283]	< 0.001	
6/year	11.489 [7.092–18.611]	< 0.001	
4/year	22.704 [7.738–66.620]	< 0.001	
3/year	6.122 [2.628–14.265]	< 0.001	
2/year	6.344 [3.514–11.455]	< 0.001	
1/year	3.966 [2447–6.428]	< 0.001	
0/year	1		
	The SASMEX:		
Knowledge warning time	Time varies	0.664 [0.500–0.880]	0.004 *
Other	1		
Usefulness			
Useful	0.939 [0.657–1.343]	0.730	

Not at all	1		
Earthquake knowledge:			
Knowledge what to do	Yes	1.525 [1.149–2.026]	0.004 *
No	1		
Knowledge vs. drills	Yes	0.865 [.661–1.132]	0.291
No	1		
Current knowledge	Scale 0–10	1.008 [0.945–1.075]	0.806
Perception seismic risk:			
Likelihood of harm	Scale 0–10	1.041 [0.984–1.102]	0.159 *
Severity of harm	Scale 0–10	1.079 [1.018–1.143]	0.011 *
Perception vulnerability city	Scale (α = 0.67)	1.342 [1.167–1.543]	< 0.001 *
	Psychological reactions:		
Negative emotions	Scale 0–10	1.352 [1.176–1.555]	< 0.001 *
Fear Sep., 19, earthquake	A lot	1.537 [1.171–2.017]	0.002 *
Not at all	1		
Worry home	Yes	1.465 [1.127–1.903]	0.004 *
No	1		

* The selected variables at significance criterion $p < 0.25$ [72]. ** Refers to the reference group.

Table 6. Multivariable logistic regression analysis of the factors predicting the likelihood of agreeing on conducting daytime drills.

Variables	Value Levels	Model 1 B	S.E.	OR [95% CI]	Model 2 B	S.E.	OR [95% CI]
			Demographics:				
Age	Cont.	0.011	0.011	1.011 [0.989–1.033]	0.015	0.006 *	1.015 [1.003–1.027]
Sex	Men	−0.134	0.148	0.875 [0.875–0.654]			
	Women	1	1	1			
Occupation	Employees	−0.073	118.177	0.929 [0.656–1.316]			
	Students	1		1			
			Earthquake Experience:				
1985 experience	Yes	−0.007	0.298	0.993 [0.553–1.781]			
	No	1		1			
Earthquake Drills:							
Frequency of drills	12/year	2.679	0.259 ***	14.573 [8.772–24.212]	2.715	0.248 ***	15.106 [9.282–24.583]
	6/year	2.270	0.261 ***	9.864 [5.812–16.136]	2.363	0.250 ***	10.628 [6.509–17.353]
	4/year	2.817	0.558 ***	16.724 [5.607–49.884]	2.921	0.553 ***	18.555 [6.278–54.839]
	3/year	1.582	0.445 ***	4.864 [2.032–11.641]	1.718	0.436 ***	5.575 [2.371–13.107]
	2/year	1.708	0.320 ***	5.518 [2.945–10.339]	1.698	0.307 ***	5.460 [2.994–9.959]
	1/year	1.278	0.257 ***	3.590 [2.169–5.940]	1.335	0.251 ***	3.800 [2.326–6.210]
	0/year	1	1	1	1	1	1

Drill participation	Yes	0.172	0.256	1.188 [.719–1.962]			
	No	1		1			
The SASMEX							
Warning time	Time varies	−0.417	0.159 **	0.659 [0.483–0.899]	-0.391	0.155 *	0.676 [0.499–0.917]
	Other			1			1
Earthquake knowledge:							
Knowledge of what to do	Very knowl.	0.368	0.164 *	1.445 [1.047–1.992]	0.346	0.160 *	1.413 [1.034–1.932]
	Not at all	1	1	1	1	1	1
Psychological reactions:							
Negative emotions	Cont.	0.113	0.087	1.120 [0.945–1.329]			
Fear of Sept. 19 earth.	A lot	0.210	0.175	1.234 [0.875–1.740]			
	Not at all	1	1	1			
Fear of home collapsing	A lot	−0.090	0.170	0.914 [0.655–1.275]			
	Not at all	1	1	1			
Perception of seismic risk:							
Likelihood of harm	Scale	−0.041	0.037	0.960 [0.892–1.033]			
Severity of harm	Scale	0.026	0.039	1.027 [0.951–1.109]			
"Perception vulnerability city" (PVC)	Scale	0.172	0.083 *	1.188 [1.009–1.399]	0.196	0.079 *	1.216 [1.041–1.420]
			-2LL		1426.903 $\chi^2 = 190.083$; $df = 10$; $p < 0.001$		
			Nagelkerke R^2		15.6%		
			Hosmer & Lemeshow test		$P = 0.540$		
			Classification accuracy		89.5%		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. "1" refers to the reference group.

3.2. Results Related to Nighttime Drills

The Multivariable Model

Regarding the dependent variable (i.e., evacuation drills any time at night), the frequency data showed that 65.3% of respondents responded "Yes" and 34.7% responded "No". Tables 7 and 8, on the other hand, show the results of the analysis.

For example, Table 7 shows the results when fitting a univariable logistic regression model for each explanatory variable considered in the analysis. At this stage of the analysis, the unadjusted effects of each of the nineteen explanatory variables was analyzed and included a single variable in the model at a time [72]. It should be highlighted that the criterion of a significance level of the initial variable selection was based on $p < 0.25$ (Section 2.2). The results show that of a total of nineteen precursors, only ten were significant at $p < 0.25$. That is, age, educational level, frequency of drills, usefulness of the SASMEX, likelihood of harm, harm severity, negative emotions, fear of home collapsing, perception vulnerability city, and the fear felt during the September 7 earthquake in 2017: these variables embrace the first multivariate model (Model 1).

Table 8 shows the final fitted model to the collected data (Model 2), and five explanatory variables were significantly associated with the outcome, that is, frequency of drills (Wald: $\chi^2(6)$ = 100.945, $p < 0.001$), age (Wald: $\chi^2(1)$ = 14.887, $p = 0.001$), negative emotions (Wald: $\chi^2(1)$ = 15.200, $p < 0.001$), educational level (Wald: $\chi^2(1)$ = 11.639, $p = 0.001$), and fear of home collapsing (Wald: $\chi^2(1)$ = 4.359, $p = 0.037$). The three most influential predictors to the outcome were the variables related to frequency of drills, age, and negative emotions (NE).

As with Section 3.1, a two-way approach to interactions was opted for; the results of this process showed that none of model terms had been demonstrated to have a significant main effect on the agreement to the outcome variable (i.e., nighttime drills).

In summary, the final fitted model (Model 2, Table 8), embraces the following variable categories: demographics (age and level of education), earthquake drills (frequency of drills), and psychological reactions (negative emotions and fear house/building collapsing).

Regarding the variable age, those whose age ranged from 13–49 years old have 1.709 times the odds of agreeing on conducting mass earthquake drills anytime at night compared to older participants (50–65) ($p < 0.001$, 95% CI 1.302–2.244).

Respondents with a higher level of education (undergraduate and postgraduate) have 1.426 times the odds of agreeing on conducting nighttime drills compared to those with a low level of education (primary/secondary/preparatory) ($p < 0.01$, 95% CI 1.163–1.749).

The results also highlighted the importance of the variable related to the frequency of drills; as mentioned above, it was one of the most influential variables that contributed to the outcome. The results show that respondents that considered the frequency of "12 drills/year" have 5.072 times the odds of conducting nighttime drills compared to those who considered none per year ($p < 0.001$, 95% CI 3.238–7.946). Similarly, those that considered "6/year", "4/year", and "2/year" have 3.940, 4.330, and 2.974 times the odds of conducting anytime nighttime drills compared to those who considered none ($p < 0.001$, 95% CI 2.496–6.218; $p < 0.001$, 95% CI 2.332–8.040; $p < 0.001$, 95% CI 1.750–5.053, respectively). In general, it may be concluded that respondents of the study agreed to conduct several earthquake mass evacuation drills per year anytime at night. (See Section 7 for further details on this).

The variable related to negative emotions (NE) was also one of the most influential on the outcome variable. The results show that for each one-unit increase of NE, the odds of agreeing on conducting night drills increase by a factor of 1.226 (22.6%) ($p < 0.001$, 95% CI 1.107–1.359).

Finally, when considering the variable related to the fear of building collapsing during the ground shaking, the results showed that the odds of conducting nighttime drills are 1.221 times higher for respondents that feared their houses would collapsed during an earthquake occurrence than those that had not feared at all ($p < 0.05$, 95% CI 1.012–1.473).

Table 7. Results of the univariable analysis of the explanatory variables—nighttime drills.

Value levels	**OR [95% CI]**	***p***	
	"1" **		
	Demographic characteristics:		
Sex	Men	0.974 [0.822–1.153]	0.758
Women	1		
Age			
13–49 years old	1.005 [0.998–1.012]	0.159 *	
50–65 years old	1		
Education level *			
Postgraduate	1.732 [1.131–2.654]	0.012	
Undergraduate		2.295 [1.649–3.195]	< 0.001
High School	1.567 [1.170–2.099]	0.003	
Elementary School	1		
Occupation			
Employees	1.017 [0.858–1.205]	0.845	
Students		1	
Location:			
Participants location	CDMX	1.072 [0.895–1.284]	0.449
EDOMX		1	

	Earthquake experience:		
1985 earthquake experience	Yes	1.113 [.924–1.340]	0.258
No	1		
	Earthquake Drills:		
Drill past participation	Yes	1.146 [0.835–1.573]	0.399
No	1		
Frequency of drills*			
12/year	5.740 [3.684–8.944]	< 0.001	
6/year	4.491 [2.861–7.048]	< 0.001	
4/year	5.009 [2.722–9.217]	< 0.001	
3/year	2.452 [1.251–4.804]	0.009	
2/year	3.302 [1.957–5.571]	< 0.001	
1/year	1.836 [1.140–2.959]	0.013	
0/year			1
	The SASMEX:		
Knowledge warning time	Time varies	1.003 [.821–1.226]	0.975
Other			1
Usefulness			
Useful	0.239 [0.935–1.310]	0.239 *	
Not at all	1		
Earthquake knowledge:			
Knowledge of what to do	Yes	1.122 [0.918–1.370]	0.261
No			1
Knowledge and drills	Yes	0.962 [0.809–1.145]	0.590
No			1
Current knowledge	Scale (0–10)	1.016 [0.974–1.060]	0.455
	Perception seismic risk:		
Likelihood of harm	Scale (0–10)	1.058 [1.019–1.098]	0.003 *
Severity of harm	Scale (0–10)	1.072 [1.031–1.115]	< 0.001 *
Perception vulnerability city	Scale (α = 0.67)	1.172 [1.062–1.293]	0.002 *
Psychological reactions:			
Negative emotions	Scale (0–10)	1.328 [1.207–1.460]	< 0.001 *
Fear of Sept 7 earthquake	A lot	1.373 [1.158–1.627]	< 0.001 *
Not at all			1
Fear of home collapsing	A lot	1.358 [1.142–1.616]	0.001 *
Not at all			1

* The selected variables at significance criterion $p < 0.25$ [72]. ** refers to the reference group.

Table 8. Multivariable logistic regression analysis of the factors predicting the likelihood of agreeing on conducting nighttime drills.

Variables	Value Levels	Model 1 B	S.E.	OR [95% CI]	Model 2 B	S.E.	OR [95% CI]
			Demographics:				
Age	13–49	0.533	0.141 ***	1.704 [1.292–2.246]	0.536	0.139 ***	1.709 [1.302–2.244]
	50–65	1	1	1	1	1	1
Level of education	High	0.343	0.105 **	1.409 [1.147–1.732]	0.355	0.104 **	1.426 [1.163–1.749]
	Low	1	1	1	1	1	1
			Earth. Drills:				
Frequency of drills	12/year	1.574	0.231 ***	4.828 [3.069–7.594]	1.624	0.229 ***	5.072 [3.238–7.946]
	6/year	1.338	0.235 ***	3.811 [2.405–6.037]	1.371	0.233 ***	3.940 [2.496–6.218]
	4/year	1.414	0.318 ***	4.112 [2.207–7.662]	1.466	0.316 ***	4.330 [2.332–8.040]
	3/year	0.781	0.351 *	2.183 [1.097–4.341]	0.776	0.347 *	2.174 [1.100–4.295]
	2/year	1.034	0.273 ***	2.814 [1.646–4.809]	1.090	0.270 ***	2.974 [1.750–5.053]
	1/year	0.528	0.248 *	1.695	0.554	0.246 *	1.739

				[1.043–2.755]			[1.074–2.817]
	0/year	1	1	1	1	1	1
			The SASMEX				
Usefulness of the SASMEX	Useful	−0.222	0.128	0.801 [0.623–1.029]			
	Not at all	1	1	1			
			Psychological reactions:				
Negative emotions (NE)	Scale	0.165	0.054 **	1.179 [1.060–1.312]	0.204	0.052 ***	1.226 [1.107–1.359]
Fear of home collapsing	A lot	0.118	0.105	1.125 [0.916–1.382]	0.200	0.096 *	1.221 [1.012–1.473]
	Not at all	1	1	1	1	1	1
Fear Sept. 7 earth.	A lot	0.161	0.103	1.174 [0.960–1.437]			
	Not at all	1	1	1			
Perception of seismic risk:							
Likelihood of harm	Scale	0.002	0.023	1.1002 [0.958–1.048]			
Severity of harm	Scale	0.029	0.024	1.030 [0.982–1.080]			
Perception vulnerability city	Scale	0.077	0.055	1.080 [0.969–1.203]			
Constant					−1.905	0.293 ***	0.149
			-2LL			2867.030	
						$\chi^2 = 170.176$; df=10; $p < 0.001$	
			Nagelkerke R^2			9.6%	
			Hosmer & Lemeshow test			$p = 0.395$	
			Classification accuracy			68.9%	

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; "1" Refers to the reference group.

4. Discussion of the Daytime Drill Results

The next section is in relation to the following research question: "What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills at any time of the day?" The results of a binary logistic regression analysis showed that five variables (of a total of nineteen explanatory variables, Table 4) were significantly related to the outcome, i.e., (a). age (demographics), (b) frequency of drills (earthquake drills), (c) warning time (SASMEX), (d) knowledge of what to do (earthquake knowledge), and (e) perception vulnerability city (PVC) (perception of seismic risk). The results also show that the most influential variable to the outcome was that related to frequency of drills.

Unlike earthquake nighttime drills (see Section 5), there have been several studies on drills being conducted at daytime (e.g., [18–21,73–75]). In what follows, each of the identified contributor variables to the dependent variable will be discussed in some detail.

4.1. On the Demographics—Age

Age was significantly associated with the outcome variable; it has been found that for every additional year of age, the odds of agreeing on conducting daytime drills increase by 1.5%. In general, the variable age as a contributor to the outcome variable is consistent with the findings reported in other studies [18–20]. Further, our results are also consistent with those reported in a study conducted in Japan where the elderly were very motivated in earthquake and tsunami drill participation, e.g., from June 2012 to December 2014, there were 55 drills where over 90% of the participants' age ranged from 50–90 years old [19] (p.6).

However, our results differ from those reported in a similar study where it was found that respondents whose age ranged from 13–49 years old were more likely to agree on conducting mass evacuation earthquake drills on a particular fixed date (ie., on 19 September yearly, see Table 9) than the over 50s [20] (p.12). However, the results show that this is not the case in our present case study, where, in fact, the opposite trend is observed. Further, the results also contrast to those reported in relation to an actual drill conducted in New Zealand, where the age influenced the lack of interest in drill participation; for example, it has been found that age and fragility (i.e., adult participants) were some of the major factors in not performing the drill [74] (p.56) and [75] (p. 6&7).

Table 9. Examples of the dates of mass earthquake drills in Mexico City and in the US.

No.	ShakeOut, US [21]		Mass Earthquake Drills, Mexico City	
	Date	**Time (a.m.)**	**Date**	**Time (a.m.)**
1	13 November2008	10:00	23 September 2008	10:30
2	15 October 2009	10:15	18 September 2009	10:30
3	21 October 2010	10:21	20 September 2010	11:00
4	20 October 2011	10:20	19 September 2011	10:00
5	18 October 2012	10:18	19 September 2012	10:00
6	17 October 2013	10:17	19 September 2013	10:00
7	16 October 2014	10:16	19 September 2014	10:00
8	15 October 2015	10:15	19 September 2015	11:30
9	20 October 2016	10:20	19 September 2016	11:00
10	19 October 2017	10:19	19 September 2017	11:00
11	18 October 2018	10:18	19 September 2018	13:16:40 p.m.
12	17 October 2019	10:17	19 September 2019	10:00

4.2. On the Frequency of Drills

As mentioned in Section 3.1.1, the variable related to frequency of drills was the most significant influencer on the outcome variable (Wald: $\chi^2(6) = 30.973$, $p < 0.001$). The results are consistent with those reported in a similar study [20]. However, they differ in the number of mass drills preferred by the participants of the study herein, i.e., participants were more open to conducting several drills per year (Table 6). The results also contrast to the current practice in Mexico City (and in the US and elsewhere) regarding the frequency of drills conducted per year. That is, the existing approach is to conduct drills on what we may called a fixed date and time, as shown in Table 9.

The existing approach raises the question as to why only one earthquake drill per year? Is this enough? However, historical earthquake occurrence data shows that earthquakes can happen any time during the day and in an unpredicted way; that is, earthquakes do not occur at a fixed date and time (Table 1). The central question is this: How can we deal with it? It may be argued that, as a society facing seismic risk, we should adapt to the dynamic nature of earthquake occurrence. That is, we should attempt to match some of the features of its spatial and temporarily patterns of occurrence. Communities should be prepared anytime at day- and at nighttime (see Section 5 for further details on this), weekdays and weekends, in winter and summertime, etc. Further, earthquakes can occur while individuals are in different places; for example, individuals (being alone or with a vulnerable person, e.g., an elderly, a child, or a person with a disability) at work, at home, in a hotel, being in a high-rise building, in the cinema, walking along a quiet street, walking along a crowded street, driving, doing shopping, being asleep, etc. Hence, in preparing for an earthquake emergency, it may become necessary to consider and develop placed-based emergency plans accordingly.

There is plenty of evidence of the spatial and temporal dimensions of a seismic emergency. For example, when residents of the capital city were asked where they were when the 19 September earthquake hit the city (it occurred at 13:14 pm, local time), their answers were the following [65]: 38% "at work", 22.8% "at home", 11.2% while walking on "the street", 1.4% "driving", and "other" (23.5%). Similarly, and in relation to the "Umbria-Marche" earthquake that hit Italy in 1997 at 15:50 pm. [76], it was reported that 29% were in company of a family member (and 49% were with "other" people), 36% were "at work", 30% "at home", 16% were on the street (11% "on foot" and 5% "were in a car"), 5% "at school", 5% "in a supermarket or shop", and 8% were in "places such as the post office, doctor's office, or hospital". Regarding the earthquakes that occurred in Japan (Hitachi) and

New Zealand (Christchurch, see Table 1), both earthquakes occurred at approximately at the same time of day (i.e., early afternoon on a weekday); similar results were reported in [77]. For example, in the case of the Hitachi earthquake, 38.3% were at home, 33.7% at their workplace, 10.8% at a public place, and 10.5% while driving. During the Christchurch earthquake, on the other hand, 44.4% were at home, 31.1% at the workplace, 9.7% in a public place, and 6.3% in a vehicle.

It may be argued that if drills are conducted in the same way and at the same time (Table 9), participants may lose interest in the drills and consequently will be less prepared for an actual emergency [19,78]. Hence, it may be argued that ideally, several drills should be conducted any time during the day; further, 50% of them should be announced and 50% unannounced. Furthermore, the time of earthquake drills should be randomly selected. In this way, we may just match the spatial–temporal dimension of an earthquake emergency. Further research is needed on this.

4.3. On the Warning Time (The SASMEX)

The main objective of the SASMEX (the "Mexican Seismic Alert System") system is to timely alert residents of the capital city to an actual ground shaking. A key variable is that related to the warning time defined as the time elapsed between the beginning of the seismic alert and the actual ground shaking (also known as "prevention time" [66]); knowing the warning time is crucial during an earthquake emergency as discussed in Ref. [39]. In our case study, the frequency data showed that the proportion of respondents that considered "Other" (e.g., "60 sec.") was 58.3% compared to 22.8% of those that considered "the time varies". That is, respondents of the study were confused on this, and as discussed elsewhere, they need further education on the working of the SASMEX. It is thought that before the 19 September 2017 earthquake (Table 1), it was widely believed that the warning time was 50 or 60 sec; however, this is not the case. For example, it was reported that if an earthquake is occurring along the Pacific coast of the country (in the subduction zone), the warning time ranges from 60—90 seconds [79]. Further, on 23 June 2020, an earthquake hit the city and the warning time was 119 seconds [80]. Furthermore, in relation to the 19 September 2017 earthquake, the warning time was null. In short, residents of the capital city need to be further educated on this matter [39].

Nevertheless, the variable warning time is a contributor to the outcome of the present case study. The results are consistent with those reported in a similar study [20]. In general, it may be argued that earthquake early warning systems are valuable if they provide timely alerts to the affected communities [79,81,82].

4.4. On Knowing What to Do during the Earthquake (Earthquake Knowledge)

It may be argued that having an effective earthquake early warning system does not necessarily mean that lives can be saved; the human response to such warnings is crucial during an emergency. That is, knowing what protective actions to take once the warning is issued is crucial to surviving during an earthquake. The results show that participants that considered themselves "very" knowledgeable on the protective actions were more likely to agree on conducting mass drills compared to those that lacked that basic knowledge. However, the results contrast with the results of a study on what actions the participants took during the 19 September 2017 earthquake [65]. For example, in that study, it has been found that 52.5% of respondent's actions during the tremors were to "escape" from the building they were in. Similar findings have been reported in [76,77]. Further, in the same study, only 13.7% of the participants sought shelter during the ground shaking [65], which was consistent with a similar study (12%) [76]. Finally, the second most frequent action respondents did during the tremor was "reaching and protecting people" (17.1%).

Given that the seismic alert was issued simultaneously as the ground was shaking, it is clear that the participants of the study should have taken some sort of protective action (e.g., "drop, cover, hold on"). Further, it is believed that running during a tremor is riskier than staying inside the building [83,84]; similarly, in Mexico, civil protection discourages people evacuating during the tremors [85]. Overall, the results show the need for further seismic risk education of what actions should be taken during an earthquake emergency and therefore the need to conduct more drills.

4.5. On the "Perception Vulnerability City" (PVC)

In general, risk perception exhibits individual's subjective judgements of the likelihood (or vulnerability) of a hazard and the severity of its consequences [86]. That is, a person's perception of a seismic risk may affect his/her behavior towards that risk. Published reports in the literature have shown that when people perceive a bigger threat (and its consequences) from the hazard, they tend to exhibit negative affect, such as fear, anger, etc., [67,87–89], which contributes to a person's sense of information insufficiency and therefore influences information seeking behavior [90–92].

Respondents were asked to indicate how serious the impact of a big earthquake hitting the capital city was [20]. The results show that for every additional unit increase of perception vulnerability of the city, the odds of agreeing to. conducting daytime drills increased by 21.6%. The results are consistent with those reported in the literature in that respondents' fear the potential consequences of a big earthquake in the city, and therefore they seek information in the form of agreeing on conducting earthquake drills.

5. Discussion on the Nighttime Drill Results

Section 3.2 presented the results in relation to the following research question: "What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills at any time of the night?" The results showed that five variables were significantly related to the outcome, i.e., (a) age and (b) level of education (demographics), (c) frequency of drills (earthquake drills), (d) fear of house collapsing, and e) negative emotions (psychological reactions).

Given the fact that there has not been any explicit published research on this issue (i.e., earthquake drills at night), it was not possible to compare our results with similar studies. Nevertheless, as mentioned in the introduction section, there has been evidence of studies and reports in relation to night fire drills in residential and hotel buildings and university housing, where it is believed that is mandatory to conduct such drills [45–48,50,51,78]. In what follows, each of the contributing factors leading to the outcome variable are discussed in the context of fire safety when necessary. (It should be highlighted that a fire is not the same as an earthquake; however, the existing literature on fire safety may shed some light on the issues involved when conducing nighttime fire drills).

5.1. On the Demographics

5.1.1. Age

The results show that age was one of the most significative variables to the outcome. Participants whose age ranged from 13–49 years old were more likely to agree on conducting mass evacuation drills anytime at night than those over 50 (Table 8). This finding was consistent with the result reported for the case of conducting drills on September 19 yearly [20]. The results are also consistent with a study conducted in New Zealand (as with the case reported in [20], the earthquake drill was conducted in daylight), where it has been found that age and fragility (i.e., adult participants) were some of the major factors in not performing the drill [75] (p.7). Moreover, it may be hypothesized that adults may have problems associated with factors such as being a heavy sleeper, being under the influence of sleeping tablets, etc., as reported by some studies in relation to fire safety in buildings [93–97]. Again, this precursor should be further investigated in the context of nighttime mass earthquake drills.

5.1.2. Educational Level

The variable related to the level of education of the participants of the study was significantly associated with the outcome variable. Respondents with higher level of education (i.e., undergraduate and postgraduate) were more likely to agree on conducting drills anytime of the night than those with a lower level of education (primary/secondary/preparatory). At this stage, we could not find an explanation on what the reasons for this were. One could hypothesize that respondents with a postgraduate degree may find it difficult to get up for work the following day, or it could be any of the factors identified in Ref. [75] (p.8). Clearly, more research is needed to further elucidate the demographic factors preventing individuals from participating in drills during the night once these are planned and implemented.

5.2. On the Frequency of Drills at Nighttime

Frequency of drills was one of the variables that significantly contributed to the dependent variable (Wald: $\chi^2(6) = 30.973$, $p < 0.001$). The results are similar to those discussed in Section 4.2 and in [20]. However, they differ in the sense of the number of mass drills preferred by the participants of the study, i.e., in general, in the present study, participants were more willing to conduct, for example, four to twelve drills per year (Table 8) than the findings reported in [20].

As mentioned in the introduction of this section, there has been a vast amount of published literature on fire safety and relevant to night fire drills [46,47,50,93–97]. For example, in relation to night fire drills, hospitals [46,47] and hotels [50] require night fire drills quarterly. Again, our results in relation to the frequency of drills are consistent with the frequency of night fire drills being conducted in these type of building occupancies. However, more research is needed on this, for example by considering human factor behavior during the seismic emergency.

The results have also highlighted that 65.3% of respondents agree on conducting mass earthquake drills anytime of the night. This may be consistent with fire safety practices in facilities such as in hospitals [46,47], university accommodation [48], fire fighters [51], and hotels [49,50]. That is, drills should be held at varying times of night; moreover, it may be argued that if drills are conducted at a fixed time and in the same manner [20], participants may lose interest in participating in the drills and consequently will be less prepared for the actual seismic emergency. Furthermore, it would be desirable that at least 50% of drills should be unannounced to simulate a real-world scenario [47]; as mentioned in Section 1.2 and Table 2, nighttime earthquakes are always unpredictable.

5.3. On the Psychological Reaction

5.3.1. Negative Affect

This variable was one of the most influential on the outcome. According to [67], negative emotions (NE) such as worry, anger, and stress could influence a person's sense of information insufficiency about the risk and prompt more active information seeking [67,68]. For example, in a study reported in [67], it was found that anger related positively to information insufficiency; that is, when people experience this negative emotion, they seek information. Our results are consistent with these studies; that is, experiencing nighttime drills respondents may feel they gain new knowledge in dealing with seismic risk at night. Having said this, more research should be conducted on this issue to explore other implications of negative and positive affect and perceived hazard characteristics, among others.

5.3.2. Fear of Collapsing House/Building

As expected, the results highlighted that respondents who were frightened that their homes would collapse during the earthquake occurrence were more likely to agree on conducting nighttime drills than those that did not. The results are consistent with the findings on the people's reactions to the 7 and 19 September 2017 earthquakes in Mexico City [65], i.e., 48.5% and 51.6% of respondents' reactions were to escape from the buildings/homes they were in during the tremors, respectively. This kind of human behavior may be explained given the fact that the main cause of being killed/injured during an earthquake is related to structural collapses [98–102]. The results highlight the need for re-fitting houses to withstand earthquakes in developing countries (e.g., Table 2). For example, a recent study that modelled a particular earthquake scenario found that the number of people that would be killed by nighttime earthquakes was lower than during daytime; according to the study, this would be mainly because during nighttime earthquakes, individuals were concentrated mostly in residential areas, which have better seismic performance, i.e., residential buildings have reinforced concrete structures [102]. However, this may not be the case in most developing countries, such as Mexico in general, and Mexico City in particular.

5.4. Some Implications of Nighttime Drills

Historical data have shown that actual earthquakes and emergencies are unexpected (Tables 1 and 2), which is one of the main reasons why earthquakes are so frightening. Further, experiencing earthquakes at night is not the same as experiencing one during daylight. There are several human aspects that are given for granted when addressing people's reactions during an earthquake emergency [65,76,77,84]. The study has highlighted some of the issues that need to be addressed in order to gain a better understanding of not only people's reactions during the ground shaking, but also the factors that may contribute to people not responding to such seismic alarms when issued at night. In relation to fire safety in buildings, "staying asleep" factors have contributed to fire death, as shown in studies of smoke alarms in buildings [93–97,103]. For example, the following risk factors [103]:

- A person being a heavy sleeper.
- A person being sleep deprived.
- Being a child or with a disability.
- A person being under the influence of sleeping tablets.
- Being a person intoxicated with alcohol.
- A person with hearing impairment (e.g., people over 50).
- Having high levels of background noise.
- Other.

It may be argued that "staying asleep" may constitute an important risk factor for earthquake death if the above "staying asleep" factors are present in a given situation. However, there is not data available to see whether any of these risk factors have contributed to people being killed during earthquakes at night (Table 2). We do not know, mainly because there are not studies on this issue; moreover, there is evidence that fire alarms have caused adverse cardiovascular events and coronary heart disease related deaths of firefighters in the US [51]. Again, these topics have not been addressed explicitly in the context of earthquakes except for a study reported in [104], where it has been found that "some but not all reports suggested more MIs (fatal myocardial infarction) associated with early morning earthquakes that woke up the population".

The above raises the question as to whether conducting earthquake drills at night may trigger cardiovascular events, such as the MIs (e.g., when the seismic alarm goes off). This issue should be further investigated and reported, in particular in those cities and regions that have installed earthquake early warning (EEW) systems, such as the SASMEX. However, what about those communities that lacked an EEW system? Have the "staying asleep" factors contributed to people being killed during nighttime earthquakes? Effectively there is no evidence in the literature on these issues. Again, more research is needed to fully understand people's reactions to nighttime earthquakes so that measures could be implemented to save lives. More generally, it may be argued that the field of human behavior in earthquakes is relatively new compared, for example, to fire safety in buildings. In fact, we can learn from fire safety science in relation to nighttime earthquake emergencies.

6. A Summary of the Contributing Factors to Mass Earthquake Drills

Table 10 summarizes the findings of the research project on the Mexico City residents' views on the issue related to earthquake drills at night and daylight and on a fixed date and time. Overall, the results showed that the categories related to demographics, earthquake drills, the SASMEX, earthquake knowledge, psychological reactions, and an interaction term ("Occupation x POV") contributed to the outcome.

Table 10. Summary of the influential factors to mass evacuation earthquake drills.

Categories	Contributing Variables to the Outcome	Mass Earthquake Drills?		
		Daytime Drills September 19 Yearly (Fixed Date & Time) [20]	Nighttime Drills (Any Time)	Daytime Drills (Any Time)
		Demographics:		
	Age	✓	✓	✓
	Educational level		✓	
	Occupation	✓		
		Earthquake Drills:		
	Frequency of drills	✓	✓	✓
		The SASMEX:		
	Warning time	✓		✓
	Usefulness	✓		
		Earthquake knowledge:		
	Knowledge of what to do			✓
	Knowledge vs. drills	✓		
		Psychological reactions:		
	Negative emotions		✓	
	Fear of home collapsing		✓	
	Perception vulnerability city (PVC)			✓
Interaction terms:	"PVC x Occupation"	✓		

7. Some Limitations of the Case Study

1. The cross-sectional study was for convenience; that is, while a sample of 2400 participants may be regarded as appropriate for the employed binary logistic regression method, the results should not be generalized to the whole population of the capital city. However, the results presented herein shed some light on issues that may be required to "validate" with a probability sample.
2. It should also be highlighted that the continuous variables related to age, "perception vulnerability city" (PVC) in the final model (Table 6), and the continuous variable related to "negative emotions" (NE) (Table 8) were assumed to have a linear relationship with the outcome. In the present analysis, both were assessed by employing the "locally weighted regression fit" (or lowess curve); overall, the plotted lowess smooth appeared nearly linear (not shown here). However, there should be a more rigorous methods to assess this, for example those related to Cubic Spline functions and fractional polynomials [72,105].
3. The variables such as "frequency of drills", "fear of earthquakes", and others were assumed to be categorical in the analysis (Tables 6 and 8); however, these could be considered continuous variables in future studies. Further, some future work may be the development of reliable and valid scales regarding some of the explanatory variables considered in the analysis.
4. The timing of the data collection may have influenced the results. That is, the results highlighted that participants were willing to participate in mass earthquake drills one per month (i.e., in both cases, daytime and nighttime). However, this may have caused some bias due to the date when the data were collected; that is, the data were collected roughly a month after the occurrence of the 7 September and 19 September earthquakes. It may be the case that participants were emotionally affected, and because of this, they were probably looking forward to more drills. This limitation stimulates to conduct further research on this and to assess whether these findings are replicated.
5. Because of the above, the results presented here should not be taken as conclusive, but have shed some light on the addressed research questions.
6. Last but not least, the findings of the study raise the question as to whether cultural issues, geographic location (i.e., communities living in seismic regions at rural level, cities, or megacities), among others, contribute to the outcome variables considered herein. It may be the

case that communities living in rural regions may show a lack of interest, for example, in nighttime drills when compared to those living in megacities, such as the present study. Further, those living in developed countries where buildings are earthquake resistant may consider earthquake drills (nighttime and daylight) unnecessary. Hence, further research is needed to shed some light on these very important issues associated with an earthquake emergency.

8. Conclusions

Historical data have demonstrated that earthquakes can happen anytime of the day and night. Drills (or exercises) may help communities to better prepare for such emergencies. A cross-sectional survey, with a sample size n = 2400, was conducted from 4 October to 20 November 2017, in Mexico City. The paper presented the results associated with the following two research questions: (1) "What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills any time of the day?" and (2) "What factors predict the likelihood that respondents would report that they agree on conducting mass evacuation drills any time of the night?" The approach employed was the application of a binary logistic regression technique to identify the leading factors to the outcome variables.

In relation to (1), the results showed that in the final model, the following five variables were significantly associated with the outcome: age, frequency of drills, warning time, knowledge on what to do, and "perception vulnerability city" (PVC). Regarding the second research question (2), five variables were also significantly associated with the outcome variable, i.e., age, level of education, frequency of drills, negative emotions, and fear of house/building collapsing. However, the results should not be generalized to the whole population of Mexico City, given the fact that the study was for convenience; see Section 7 for further details of the limitations of the study.

More generally, several drills should be conducted any time of the day and night; further, 50% of them should be announced and 50% unannounced. Furthermore, the time of earthquake drills should be randomly selected. In this way, we may just match the spatial–temporal dimension of an earthquake emergency.

However, before implementing the above, the key decision makers should (a) inform the residents of the capital city on the need to conduct several earthquake drills at night and daylight; (b) implement educational programs on the functioning of the SASMEX system, in particular, with the topic associated with the warning time; (c) implement educational programs at all levels on what actions should be taken if an earthquake strikes at daylight and nighttime; (d) develop and communicate place-based emergency plans (Section 4.2); and (e) communicate the main findings on the residents' performance on the night and daytime earthquake drills so that lessons can be learned; the feedback may help to improve the residents' level of preparedness during an earthquake emergency.

Funding: This project was funded by CONACYT (Consejo Nacional de Ciencia y Tecnología) and SIP-IPN under the following grants: CONACYT-No: 248219 & SIP-IPN: No-20201790.

Acknowledgments: The author wishes to acknowledge the research team, external experts, and those who helped to conduct the survey, many of whom provided valuable discussions. Additionally, thanks to the two anonymous journal reviewers for their helpful and insightful comments.

Conflicts of Interest: The author declares no conflict of interest.

References

1. FEMA (Federal Emergency Management Agency). Federal Emergency Management Agency. Available online: https://www.fema.gov/ (accessed on 17 February 2020).
2. CENAPRED. National Centre for Disaster Prevention. Available online: https://www.gob.mx/cenapred (accessed on 17 February 2020).
3. UN/ISDR (United Nations International Strategy for Disaster Reduction). *Global Survey of Early Warning Systems*; UNISDR: Geneva, Switzerland, 2006.

4. CDMX (Mexico City). Mexico City Earthquake Drills. Available online: http://data.proteccioncivil.cdmx.gob.mx/simulacros/CDMX/Antecedentes.html (accessed on 13 March 2020). (In Spanish)
5. Greer, A. Earthquake preparedness and response: Comparison of the United States and Japan. *Leader Manag. Eng.* **2012**, *12*, 111–125.
6. Hayashi, H. A comparison of the emergency management system between Japan and the United States. In *Assessment of Post-Event Management Processes Using Multi-Media Disaster Simulation*; Meguro, K., Ed.; US-Japan Cooperative Research on Urban Earthquake Hazard Mitigation, University of Tokyo: Tokyo, Japan, 2004; pp. 2-25–2-30.
7. Waugh, W., Jr. Public administration, emergency management, and disaster policy. In *Disciplines, Disaster and Emergency Management*; McEntire, D.A.; Ed.; Federal Emergency Management Agency, Emergency Management Institute: Washington, DC, USA, 2007; pp. 161–169.
8. Nakasu, T.; Ono, Y.; Pothisiri, W. Why did Rikuzentakata have a high death toll in the 2011 Great East Japan earthquake and tsunami disaster? Finding the devastating disaster's root causes. *Int. J. Disaster Risk Reduct.* **2018**, *27*, 21–36.
9. Brennan, D. Guatemala Volcano Eruption Warnings 'Came too Late' Officials Admit. 2018. Available online: https://www.newsweek.com/guatemala-volcano-eruption-warnings-came-too-late-officials-admit-966315 (accessed on 28 May 2020).
10. Alexander, D. Vocanic ash in the atmosphere and risk for civil aviation: A study in European Crisis Management. *Int. J. Disaster Risk Reduct.* **2013**, *4*, 9–19.
11. Chakraborty, I.; Maity, P. COVID-19 outbreak: Migration, effects on society, global environment and prevention. *Sci. Total Environ.* **2020**, *728*, 1–7.
12. Yang, J.; Chen, J.; Liu, H.; Zhang, K.; Ren, W.; Zheng, J. The Chinese national emergency medical rescue team response to the Sichuan Lushan earthquake. *Nat. Hazards.* **2013**, *69*, 2263–2268.
13. Hing-Ho, T. Should we design buildings for lower-probability earthquake motion. *Nat. Hazards.* **2011**, *58*, 853–857.
14. BBC (British Broadcast Corporation). Indonesia Earthquake and the Tsunami: How Warning System Failed the Victims. 2018. Available online: https://www.bbc.com/news/world-asia-45663054 (accessed on 24 December 2019).
15. McKernan, B. Powerful Earthquake Rocks Turkish Coast and Greek Islands. 2020. Available online: https://www.theguardian.com/world/2020/oct/30/powerful-earthquake-rocks-turkish-coast-and-greek-islands-izmir (accessed on 30 October 2020).
16. CENAPRED (National Centre for Disaster Prevention). *Practical Guidance for Facilities Evacuation Drills*; CENAPRED: Mexico City, Mexico, 2014.
17. ECDC (European Centre for Disease Prevention and Control.). Handbook on Simulation Exercises in EU Public Health Settings. ECDC. 2014. Available online: https://www.ecdc.europa.eu/en/publications-data/handbook-simulation-exercises-eu-public-health-settings (accessed on 23 April 2020).
18. World Bank. *Learning from disaster simulation drills in Japan*; International Bank for Reconstruction and Development/International Development Association of the World Bank: Washington, DC, USA, 2016. Available online: http://pubdocs.worldbank.org/en/419601484285362538/011717-drmhubtokyo-Learning-From-Disaster-Simulation-Drills-in-Japan.pdf (accessed on 28 May 2020).
19. Sun, Y.; Yamori, K. Risk management and technology: Case studies of tsunami evacuation drills in Japan. *Sustainability* **2018**, *10*, 2982.
20. Santos-Reyes, J. Factors motivating Mexico City residents to earthquake mass evacuation drills. *Int. J. Disaster Risk Reduct.* **2020**, *49*, 1–9.
21. ShakeOut. ShakeOut Updates. Available online: https://www.shakeout.org/updates/ (accessed on 25 April 2020).
22. Skryabina, E.A.; Betts, N.; Reedy, G.; Riley, P.; Amlot, R. The role of emergency preparedness exercises in the response to a mass casualty terrorist incident: A mixed methods study. *Int. J. Disaster Risk Reduct.* **2020**, *46*, 101503.
23. Feng, X.; Zhang, Z.; He, Y. Analysis on chemical industry park emergency drill escape paths based on WebGIS. *Procedia Eng.* **2012**, *45*, 722–726.
24. Chun, W.; Lei, L.; Jiwu, Y.; Liangyun, Z.; Gang, L. Development of Emergency drills system for Petrochemical plants based on WebVR. *Procedia Environ. Sci.* **2011**, *10*, 313–318.

25. Xiao-Xia, G.; Wei, D.; Hong-Yu, J. Study on the social psychology and behaviours in a subway evacuation drill in China. *Procedia Eng.* **2011**, *11*, 112–119.
26. Alim, S.; Kawabata, M.; Nakazawa, M. Evaluation of disaster preparedness training and disaster drill for nursing students. *Nurse Educ. Today* **2015**, *35*, 25–31.
27. Haverkort, J.J.M.; Biesheuvel, T.H.; Bloemers, F.W.; de Jong, M.B.; Hietbrink, F.; van Spengler, L.L.; Leenen, L.P.H. Hospital evacuation: Exercise versus reality. *Injury* **2016**, *47*, 2012–2017.
28. NATO (North Atlantic Treaty Organization). Key NATO and Allied Exercises in 2019. 2019. Available online: https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_2019_02/1902-factsheet_exercises_en.pdf (accessed on 25 April 2020).
29. Hosseini, K.A.; Izadkhah, Y.O. From "Earthquake and safety" school drills to "safe school-resilient communities": A continuous attempt for promoting community-based disaster risk management in Iran. *Int. J. Disaster Risk Reduct.* **2020**, *45*, 101512.
30. Xudong, C.; Heping, Z.; Qiyuan, X.; Yong, Z.; Hongjiang, Z.; Chenjie, Z. Study of announced evacuation drill from a retail store. *Build. Environ.* **2009**, *44*, 864–870.
31. Ahmadun, F.R.; Ridwan-Wong, M.M.; Said, A.M. Consequences of the 2004 Indian Ocean Tsunami in Malaysia. *Saf. Sci.* **2020**, *12*, 619–631.
32. Imaizumi, A.; Ito, K.; Okazaki, T. Impact of natural disasters on industrial agglomeration: The case of the Great Kantō Earthquake in 1923. *Explor. Econ. Hist.* **2016**, *60*, 52–68.
33. Kiani, Q.H.; Qazi, M.; Khan, A.; Iqbal, M. The relationship between timing of admission to a hospital and severity of injuries following 2005 Pakistan earthquake. *Chin. J. Traumatol*. **2016**, *19*, 221–224.
34. Nay, I. Comparing the direct human impact of natural disasters for two cases in 2011: The Christchurch earthquake and the Bangkok flood. *Int. J. Disaster Risk Reduct.* **2015**, *13*, 61–65.
35. Tachibana, T.; Goto, R.; Sakurai, T.; Rayamajhi, S.; Adhikari, A.; Dow, W.H. Do remittances alleviate negative impacts of disaster on mental health? A case of the 2015 Nepal earthquake. *Soc. Sci. Med.* **2019**, *283*, 112460.
36. Levie, F.; Burke, C.M.; Lannon, J. Filling the gaps: An investigation of project governance in a non-governmental organisation's response to the Haiti earthquake disaster. *Int. J. ProJ. Manag.* **2017**, *35*, 875–888.
37. Zhang, W.; Xu, X.; Chen, X. Social vulnerability assessment of earthquake disaster based on the catastrophe progression method: A Sichuan Province case study. *Int. J. Disaster Risk Reduct.* **2017**, *24*, 361–372.
38. Stirling, M.; Langridge, R.; Benites, R.; Aleman, H. *The Magnitude 8.3 June 23 2001 Southern Peru Earthquake and Tsunami: Reconnaissance team Report*; Institute of Geological & Nuclear Sciences: Lower Hart, New Zealand, 2002.
39. Santos-Reyes, J. How useful are EEW? The case of the 2017 earthquakes in Mexico City. *Int. J. Disaster Risk Reduct.* **2019**, *40*, 101148.
40. SSN (National Seismological Service). The 1985 Earthquake Factsheet (In Spanish). 2020. Available online: https://web.archive.org/web/20080408054816/www.ssn.unam.mx/website/jsp/Carteles/sismo85.jsp (accessed on 28 May 2020).
41. NDRRMC (National Disaster Risk Reduction and Management Council). *Effects of Magnitude 7.2 Sagbayan, Bohol Earthquake-Update*; NDRRMC: Quezon, Philippines, 2013; pp. 1–12. Available online: https://reliefweb.int/report/philippines/ndrrmc-update-sitrep-no-35-re-effects-magnitude-72-sagbayan-bohol-earthquake (accessed on 25 April 2020).
42. ADRC (Asian Disaster Reduction Center). Details of Disaster Information. Available online: http://www.adrc.asia/view_disaster_en.php?NationCode=392&lang=en & KEY=1497 (accessed on 25 April 2020).
43. Fisher, L.B. A nurse's earthquake experience. *Am. J. Nurs.* **1906**, *7*, 84–98.
44. La Gente (Radio La Primerísima). Suman 32 Muertos tras Fuerte Terremoto de 8.2 Grados en México, 2017. Available online: http://www.radiolaprimerisima.com/noticias/general/228300/suman-32-muertos-tras-fuerte-terremoto-de-82-grados-en-mexico/ (accessed on 25 August 2020).
45. NFEC (The National Fire and Civil Emergency Preparedness Council). Effective Evacuation Procedures–Mass Fire Evacuation Drill at Yishun Health Campus. The National Fire and Civil Emergency Preparedness Council (NFEC) & the Singapore Civil. Defence Force (SCDF). 2018. Available online: https://www.scdf.gov.sg/docs/default-source/scdf-library/fssd-downloads/fsm/fsm-seminar-2019/04-effective-evacuation-procedures.pdf (accessed on 25 April 2020).

46. ISDH (Department of Health & Human Resources). Report on the Emergency Preparedness Survey at the Newburgh Health Care, Indiana, US. 2018. Available online: https://www.in.gov/isdh/reports/QAMIS/ltccr/9pu921_2567.pdf (accessed on 17 February 2020).
47. EHS (Environmental Health & Safety). Patient Care Areas-Fire Drills. University of Rochester. 2018. Available online: https://www.safety.rochester.edu/fire/pdf/policyprocedure/FS_PatientCareAreasFireDrill.pdf (accessed on 23 April 2020).
48. FS-IC (Fire safety, Imperial College). Fire Safety in Imperial's Student Accommodation. 2020. Available online: https://www.imperial.ac.uk/study/campus-life/accommodation/fire-safety-in-imperials-student-accommodation/ (accessed on 17 February 2020).
49. Kobes, M.; Helsloot, I.; de Vries, B.; Post, J.G.; Oberijé, N. Way finding fire evacuation; an analysis of unannounced fire drills in a hotel at night. *Build. Environ.* **2010**, *45*, 537–548.
50. FD-NYC (Fire Department, City of New York). Study Material for the Examination for Certificate of Fitness for-F07 Fire and Emergency Drill Conductor (Premises Related) W-07 Fire and Emergency Drill Conductor (Citywide). New York City Fire Department. 2014. Available online: http://www.nyc.gov/html/fdny/pdf/cof_study_material/f_07_w_07_st_mat.pdf (accessed on 17 February 2020).
51. Hall, S.J.; Aisbett, B.; Tait, J.L.; Turner, A.I.; Ferguson, S.A.; Main, L.C. The acute psychological stress response to an emergency alarms and mobilization during the day and at night. *Noise Health.* **2016**, *18*, 150–156.
52. Panzar, J. Army invades L.A.'s Space: Black Helicopters, Loud Booms, Simulated Gunfire Are all Part of the Drill. Los Angeles Times. 2019. Available online: https://www.latimes.com/local/lanow/la-me-ln-military-training-20190207-story.html (accessed on 25 April 2020).
53. Salinas, C.; Kurata, J. The effects of the Northridge earthquake on the pattern of emergency department care. *Am. J. Emerg. Med.* **1998**, *16*, 254–256.
54. Yamazaki, Y.; Cheung, K.F. Shelf resonance and impact of near-field tsunami generated by the 2010 Chile earthquake. *Geophys Res. Lett.* **2011**, *38*, 1–8.
55. Andre, M. The earthquake in Chile. In *The state of Environment Migration 2010;* Gemenne, F., Bruker, P., Glasser, J., Eds.; Institute for Sustainable Development and International Relations/International Organization for Migration: Geneva, Switzerland, 2010. Available online: https://publications.iom.int/system/files/pdf/study0711_sem2010_web3.pdf (accessed on 25 April 2020).
56. Contreras, D.; Forino, G.; Blaschke, T. Measuring the progress of a recovery process after an earthquake: The case of L'aquila, Italy. *Int. J. Disaster Risk Reduct.* **2018**, *28*, 450–464.
57. Ramazi, H.; Jigheh, H.S. The Bam (Iran) Earthquake of December 26, 2003: From an engineering and seismological point of view. *J. Asian Earth Sci.* **2006**, *27*, 576–584.
58. Maruyama, S.; Kwon, Y.; Morimoto, K. Seismic intensity and mental stress after the Great Hanshin-Awaji Earthquake. *Environ. Health Prev. Med.* **2001**, *6*, 165–169.
59. Vanholder, R.; Sever, M.S.; De Smet, M.; Erek, E.; Lameire, N. Intervention of the renal disaster relief task force in the 1999 Marmara, Turkey earthquake. *Kidney Int.* **2001**, *59*, 783–791.
60. BBC. Earthquake Wreaks Devastation in Nicaragua, 1972. Available online: News.bbc.co.uk/onthisday/low/dates/stories/december/23/newsid_2540000/2540045.stm (accessed on 17 February 2020).
61. Ambraseys, N. The earthquake of Managua, Nicaragua, 1972. *Nature* **1973**, *244*, 427–428.
62. Tien, Y.M.; Juang, J.; Chen, J.M.; Pai, C.H. Isointensity-isoexposure concept for seismic vulnerability analysis—A case study of the 1999 Chi-Chi, Taiwan earthquake. *Eng. Geol.* **2012**, *131*, 1–10.
63. Hamdache, M.; Pelaez, J.A.; Yelles-Chauche, A.K. The Algiers, Algeria earthquake (M_W 6.8) of 21 May 2003: Preliminary report. *Seismol. Res. Lett.* **2004**, *75*, 360–367.
64. Arefev, S.S.; Dorbath, K. The 1995 Neftegorsk earthquake: Tomography of the source zone. *Izvestiya Phys. Solid Earth* **2001**, *37*, 141–150.
65. Santos-Reyes, J.; Gouzeva, T. Mexico City's residents emotional and behavioural reactions to the 19 September 2017 earthquake. *Environ. Res.* **2020**, *186*, 109482.
66. Espinosa-Aranda, J.M.; Cuellar, A.; Rodríguez, F.H.; Frontana, B.; Ibarrola, G.; Islas, R.; Garcia, A. The seismic alert system of Mexico (SASMEX): Progress and its current applications. *Soil Dyn. Earthq. Eng.* **2011**, *31*, 154–162.

67. Griffin, R.J.; Yang, Z.; ter Huurne, E.; Boerner, F.; Ortiz, S.; Dunwoody, S. After the flood-Anger, attribution, and the seeking information. *Sci. Commun.* **2008**, *29*, 285–315.
68. Yang, Z.J.; Kahlor, L.A. What, Me Worry? The role of affect in information seeking and avoidance. *Sci. Commun.* **2012**, *35*, 189–212.
69. Hernández-Moreno, G.; Alcántara-Ayala, I. Landslide risk perception in Mexico: A research gate into public awareness and knowledge. *Landslides* **2017**, *14*, 351–371.
70. Becker, J.S.; Paton, D.; Johnston, D.M.; Ronan, K.R.; McClure, J. The role of prior experience in informing and motivating earthquake preparedness. *Int. J. Disaster Risk Reduct.* **2017**, *22*, 179–193.
71. Cohen, J.; Cohen, P.; West, S.G.; Aiken, L.S. *Applied Multiple Regression/Correlation Analysis for the Behavioural Sciences*; Third Edition, Lawrence Erlbaum Associates: Mahwah, NJ, USA, 2003.
72. Hosmer, D.W.; Lemeshow, S.; Sturdivant, R.X. *Applied Logistic Regression*; John Wiley & Sons: Hoboken, NJ, USA, 2013.
73. Adams, R.M.; Karlin, B.; Eisenman, D.P.; Blakley, J.; Glik, D. Who Participates in the Great ShakeOut? Why Audience Segmentation Is the Future of Disaster Preparedness Campaigns. *Int. J. Environ. Res. Public Health.* **2017**, *14*, 1407.
74. Becker, J.S.; Coomer, M.A.; Potter, S.H.; McBride, S.K. New Zealand 2012 ShakeOut drill: A survey evaluation one year on. Lower Hutt (NZ). In *GNS Science Report 2016/52*. GNS Science: Lower Hutt, New Zealand, 2017, doi:10.21420/G2PS3C.
75. McBride, S.; Becker, J.S.; Johnston, D.M. Exploring the barriers for people taking protective actions during the 2012 and 2015 New Zealand ShakeOut drills. *Int. J. Disaster Risk Reduct.* **2019**, *37*, 1–11.
76. Prati, G.; Catufi, V.; Pietrantoni, L. Emotional and behavioural reactions to tremors of the Umbria-Marche earthquake. *Disasters* **2012**, *36*, 439–451.
77. Lindell, M.K.; Prater, C.S.; Wu, H.C.; Huang, S.; Johnston, D.M.; Becker, J.S.; Shiroshita, H. Immediate behavioural responses to earthquakes in Christchurch, New Zealand, and Hitachi, Japan. *Disasters* **2016**, *40*, 85–111.
78. NFPA (National Fire Protection Association). NFPA 101®, Life Safety Code®, 2000th ed. Available online: https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=101 (accessed on 25 April 2020).
79. Cuellar, A.; Suarez, G.; Espinosa-Aranda, J.M. Performance evaluation and classification algorithm 2(t_S–t_P) of the seismic alert system of Mexico (SASMEX). *Bull. Seismol. Soc. Am.* **2017**, *107*, 1451–1463.
80. CIRES (Centre for Instrumentation and Seismic Record, A.C.). Preliminary Bulletin of the Mexican Seismic Alert System (SASMEX). Available online: http://www.cires.org.mx/sasmex_reporte_alerta_es.php (accessed on 27 June 2020).
81. Cochran, E.S.; Kohler, M.D.; Given, D.D.; Guiwits, S.; Andrews, J.; Meier, M.A.; Ahmad, M.; Henson, I.; Hartog, R.; Smith, D. Earthquake early warning ShakeAlert system: Testing and certification platform. *Seismol. Res. Lett.* **2017**, *89*, 108–117.
82. Nakamura, Y.; Saita, J.; Sato, T. On an earthquake early warning system (EEW) and its applications. *Soil Dyn. Earthq. Eng.* **2011**, *31*, 127–136.
83. Shoaf, K.I.; Sareen, H.R.; Nguyen, L.H.; Bourque, L.B. Injuries as a result of California earthquakes in the past decade. *Disasters* **2002**, *22*, 218–235.
84. Goltz, J.; Bourque, L.B. Earthquakes and human behaviour: A sociological perspective. *Int. J. Disaster Risk Reduct.* **2017**, *21*, 251–265.
85. Gutierrez-Martinez, C.; Quaas-Weppen, R.; Ordaz-Schroeder, M.; Guevara-Ortiz, E.; Muriá-Vilá, D.; Krishina-Singh, S. *Sismos. Centro Nacional de Prevencion de Desastes (CENAPRED)*; Secretaría de Gobernación: Mexico City, Mexico, 2015.
86. Li, S.; Zhai, G.; Zhou, S.; Fan, C.; Wu, Y.; Ren, C. Insight into the earthquake risk information seeking behaviour of the victims: Evidence from Songyuan, China. *Int. J. Environ. Res. Public Health* **2017**, *14*, 1–16.
87. Griffin, R.J.; Neuwirth, K.; Dunwoody, S.; Giese, J. Information sufficiency and risk communication. *Media Psychol*. **2004**, *6*, 23–61.
88. Ter Huurne, E.F.J.; Griffin, R.J.; Gutteling, J.M. Risk information seeking among U.S. and Dutch residents. *Sci. Commun.* **2009**, *31*, 215–237.
89. Krikelas, J. Information seeking behavior: Patterns and concepts. *Drexel Libr. Q.* **2007**, *19*, 5–20.
90. Ter Huurne, E.; Gutteling, J. Information needs and risk perception as predictors of risk information seeking. *J. Risk Res.* **2008**, *11*, 47–862.

91. Kellens, W.; Zaalberg, R.; Maeyer, P.D. The Informed Society: An Analysis of the Public's Information-Seeking Behavior Regarding Coastal Flood Risks. *Risk Anal.* **2012**, *32*, 1369–1381.
92. Neuwirth, K.; Dunwoody, S.; Griffin, R.J. Protection motivation and risk communication. *Risk Anal.* **2000**, *20*, 721–734.
93. Kahn, M.J. Human Awakening and Subsequent Identification of Fire-related Cues. *Fire Technol.* **1984**, *20*, 20–26.
94. Proulx, G.; Richardson, J.K. The human factor: Building designers often forget how important the reactions of the human occupants are when they specify fire and life safety systems. *Can. Consult. Eng.* **2002**, *43*, 35–36.
95. Pauls, J. The movement of people in buildings and design solutions for means of egress. *Fire Technol.* **1984**, *20*, 27–47.
96. Runyan, C.W.; Bangdiwala, S.I.; Linzer, M.A.; Sacks, J.J.; Butts, J. Risk Factors for Fatal Residential Fires. *N. Engl. J. Med.* **1992**, *327*, 859–863.
97. Bruck, D. The Who, What, Where and Why of Waking to Alarms: A Review. *Fire Saf. J.* **2001**, *36*, 623–639.
98. Coburn, A.W.; Spence, R.J.S.; Pomonis, A. Factors determining human casualty levels in earthquakes: Mortality prediction in building collapse. In Proceedings of the tenth world conference on earthquake engineering, Madrid, Spain, 19–24 July 1992; pp. 5989–5994
99. Yon, B.; Onat, O.; Oncu, M.E.; Karasin, A. Failures of masonry dwelling triggered by east Anatolian fault earthquakes in Turkey. *Soil Dyn. Earthq. Eng.* **2020**, *133*, 106126.
100. Khadka, B. Mud masonry houses in Nepal: A detailed study based on entire reconstruction scenario in 31 earthquake-affected districts. *Structures* **2020**, *25*, 816–838.
101. Franke, K.W.; Candia, G.; Mayoral, J.M.; Wood, C.M.; Montgomery, J.; Hutchison, T.; Morales-Velez, A. Observed building damage patterns and foundation performance in Mexico City following the 2017 M7.1 Puebla-Mexico City earthquake. *Soil Dyn. Earthq. Eng.* **2019**, *125*, 105708.
102. Yuan, H.; Gao, X.; Qi, W. Modeling the fine-scale spatiotemporal pattern of earthquake casualties in cities: Application to Haidian District, Beijing. *Int. J. Disaster Risk Reduct.* **2018**, *34*, 412–422.
103. Bruck, D.; Ball, M. Sleep and fire: Who is at risk and can the risk be reduced? In *Fire Safety Science, Proceedings of the Eighth International Symposium, Beijing, China, 18–23 September 2005*; Gottuk, D.T., Lattimer, B.Y., eds.; International Association for Fire Safety Science: London, UK, 2005; pp. 37–51.
104. Kloner, R.A. Lessons learned about stress and the heart after major earthquakes. *Am. Heart J.* **2019**, *215*, 20–26.
105. Harrell, E.E. *Regression Modelling Strategies with Applications to Linear Models, Logistic Regression and Survival Analysis*; Springer: Berlin/Heidelberg, Germany, 2001.

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2020 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).