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Change in the self-reported health status of residents associated with the reduced aircraft noise around Tan Son Nhat Airport after the epidemic outbreak

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ABSTRACT

The change in the self-reported health status of residents associated with the reduced aircraft noise around Tân Sơn Nhất airport (TSN) after the epidemic outbreak in early 2020 was investigated in three surveys. Survey 1 is pre-outbreak when the airport was operating at its highest capacity. Surveys 2 and 3 are three months and six months after the stop of international flight operation implemented in March 2020. Data on the residents' health status was obtained from face-to-face interviews. The questionnaire items were composed of Noise annoyance questions using the 11-point ICBEN scale, the Total Health Index, Health and lifestyle questionnaire, Depression Scale revised questionnaire, and questionnaires to identify insomnia, hypertension, and hearing loss. Other factors related to living conditions such as education, income, or housing were also collected as health adjustment factors. The noise levels of Surveys 2 and 3 were estimated by updating the noise contour map of Survey 1 using the TSN airport's operation data in corresponding periods in 2020. This study provided evidence relating to variation of the residents' health status due to the noise situation changes.

1. INTRODUCTION

Many studies have focused primarily on annoyance and sleep disorders as the main effects of noise. However, recent epidemiological studies in Europe have shown high-quality evidence that shows the relation between noise and the development of ischemic heart disease (IHD). Various noise-induced health hazards have been reported such as the occurrence of cognitive impairment in children, an increased risk of hypertension, and an increase in body mass index (BMI) [1]. However, there is a lack of basic data to make such knowledge about health hazards of noise a common understanding outside the academic reports, and there have been very few research studies mentioning such problem especially in developing countries.

The Tân Sơn Nhất (TSN) international airport—located inside a very dense residential area of Ho Chi Minh City, the most active metropolitan area in Vietnam—is the largest airport in Vietnam, with over 250,000 movements, and it served approximately 40 million passengers in 2018 [2]. The number of operated flights and passengers at the TSN airport has increased continuously over years. Extremely high exposures to aircraft noise existed in almost all areas in the vicinity of TSN. The average noise level range increased from 53–71 dB L_{den} (day-evening-night-weighted sound pressure level) in 2008 to 63–81 dB in 2019 around TSN [3]. However, after the epidemic outbreak in early 2020 Vietnam blocked a part of international flights from and to TSN in January and completely shut down its borders in March, 2020. This flight restriction has led to the significant changes of noise situation around TSN.

Since very fewer studies have looked at the step changes in noise exposure levels due to changes in airport operational conditions [3,4], this study focussed on changes in the self-reported health status of residents around TSN in association with the decreased aircraft noise exposure. It is expected to provide important evidence about health hazards of noise especially in step-change condition. The investigation was conducted in three surveys. Survey 1 is pre-outbreak when TSN was operating at its highest capacity. Surveys 2 and 3 are three months and six months after the complete stop of international flight operation implemented in March 2020. This study investigated whether (1) knowledge about health hazards caused by noise is found in developing countries, and (2) whether the WHO knowledge obtained based on the data of developed countries is applicable to developing countries.

2. METHODS

2.1. Investigation areas

TSN Airport has two parallel runways: 07L / 25R and 07R / 25L located close to each other, so it is impossible to have two flights taking off and landing simultaneously, but must take turns. Once one takes off, the other can land. The three surveys in 2019 and 2020 include twelves residential areas which were selected around the airport, five sites under the landing route (Sites 1-5), four sites under the take-off route (Sites 6-9) of aircraft and one site lying to the southwest of the north runway. The target site selection was intended to reflect the aircraft noise exposure covering locations at various distances from and in directions relative to the airport. Two control sites (Sites 11 and 12) that are not affected by aircraft noise were located about 6 km north of the airport (Figure 1).

2.2. Aircraft noise estimation

In Survey 1, both noise measurement and prediction were conducted to clarify the accuracy of noise contour map calculation. This prediction was performed using the Integrated Noise Model (INM), and flight track data was collected using a receiver of Automatic Dependent Surveillance-Broadcast (ADS-B). According to the flight logs of the entire survey period provided by the airport office, the average arrival and departure flight events of each aircraft type in INM were counted and classified into the day (06:00-18:00), evening (18:00-22:00), and night (22:00-6:00) periods and into flight routes. The day-evening-night-weighted sound pressure level (L_{den}) and the night-time equivalent continuous sound pressure level (L_{night}) were calculated. The noise levels of Survey 2 and Survey 3 were estimated by updating the noise contour map of Survey 1 using the TSN airport's operation data in corresponding periods in 2020 and referring to the flight path information of TSN airport on the Flightradar24 flight tracking service.

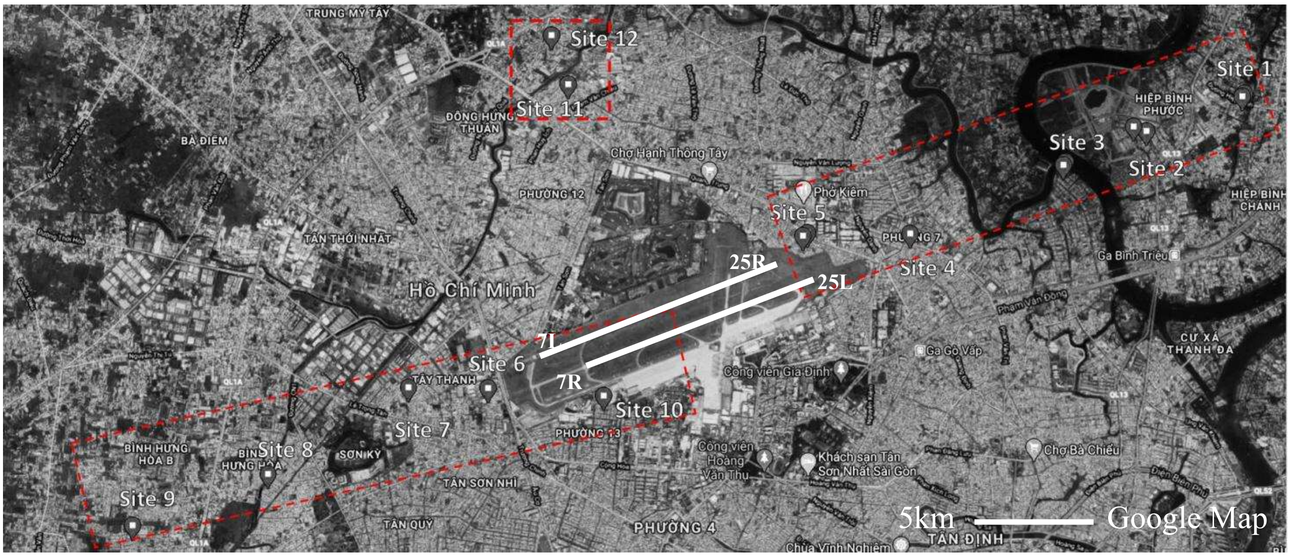

Figure 1: Tân Sơn Nhất International Airport and survey sites

2.3. Questionnaire survey

Face-to-face interviews were conducted in all three surveys: Survey 1 (August 2019), Survey 2 (June 2020), Survey 3 (September 2020), and used a questionnaire that includes items concerning general discomfort, sleep disturbance, health status, and living environment. The questionnaire items were composed referring Technical Specification ISO/TS 15666 [9], the Total Health Index or Todai Health Index (THI) [10], Komo-Ise Study health and lifestyle questionnaire [10], Center for Epidemiologic Studies Depression Scale Revised (CESD-R10) [11], Kadena Study insomnia and hypertension questionnaire [12], and questions to identify insomnia and hearing loss [13,14].

Survey 2 was conducted by re-visiting residents who participated in Survey 1. Furthermore, residents' health status data were collected to assess the effects of aircraft noise around TSN airport; therefore, some duplicate questions were excluded. In Survey 3, the interviews were conducted with other residents who lived in the same area as participants of Surveys 1 and 2. The main noise effect considered in this study is residents' self-reported health status under the reduction in the number of flights during the Corona pandemic. Table 1 shows the differences among the questionnaires used in the three surveys of the study.

Stress, morbidity, salt and alcohol intake, smoking habits, and exercise routine are considered variables that moderate the health outcomes. An inquiry on depression was referred from the Center for Epidemiologic Studies Depression Scale (CESD), created in 1977 [11]. The 20 items in the CESD-R scale measure symptoms of depression in nine different groups, as defined by the American

Psychiatric Association Diagnostic and Statistical Manual, fifth edition (DSM-5): Sadness (Dysphoria), Loss of interest (Anhedonia), Appetite, Sleep, Thinking or concentration, Guilt (Worthlessness), Tired (Fatigue), Movement (Agitation), and Suicidal ideation.

Table 1: Questionnaire items in three surveys

Items		**Survey 1**	**Survey 2**	**Survey 3**
1. Residential factors	Type of house; length of residence; ground floor area; area preference; self-assessed housing quality; duration staying at home; housing structure	Q1~Q5, Q16, F1~F9	Q1, Q2 Q14	Q1~Q5, Q17, F1~F9
2. Annoyance	Annoyed factors: airplane, traffic, factories, neighbours, vibration, exhausted fumes, smoke discharged from factories, odors, dust	Q6, Q7	Q3, Q4	Q6~Q8
3. Effects on sleep	Sleep trouble; sleep duration; self-rated sleep quality; insomnia	Q8~Q11	Q5~Q8	Q9~Q12
4. Personal factors				
Coping and attitudes	Airplane flying through; opening windows in seasons; personal sensitivity to weather and environmental factors	Q12~Q14	Q9,Q10,Q12	Q13~Q15
Occupation		Q15	Q13	Q15
Income and education	Number of vehicles; monthly income; educational background	Q34~36		Q35,Q39,Q41
Living conditions				Q36,Q37,Q38
5. Health indexes				
Self-reported health status		Q17	Q15	Q18
Life satisfaction		Q18	Q16	Q19
Stress		Q19	Q17	Q20
Health examination's frequency		Q20	Q18	Q21
Morbidity	Heart trouble, high blood pressure or hypertension, hyperlipaemia, stroke or TIA, asthma, diabetes, cancer, depression or neurosis	Q22, Q23	Q19	Q23,Q24
Salt intake	Frequency of salt intake; salty food: pickles, fish sauce, soy sauce, braised fish	Q24~Q26		Q25~Q27
Nutrition, alcohol, smoke, exercise routine		Q27~Q30	Q20	Q28~Q31
Hearing ability	Difficulty in hearing conversation; deafness, tinnitus; hearing ability of left ear and right ear	Q31	Q22	Q32
Depression		Q32	Q21	Q33
Malaise	Questions related with malaise was only asked out of all 130 questions in Total Health Index (THI).	Q33	Q23	Q34
Height, weight, blood pressure		Q37, Q38	Q26	Q42

Total Health Index (THI) encompasses 130 questions about lifestyle, personal preference, physical symptoms, and mental-condition-related complaints [10]. In this study, 20 questions related with malaise were selected from a total of 130 items. The scores obtained from all the questions are summed to form a total score, ranging from 20 to 60 points.

The question format used to investigate hearing problems included screening questions and self-rating scales [11].

How much difficulty do you have hearing and understanding words in a normal conversation (even with a hearing aid)?

1. A great deal 2. Some 3. A little 4. None

Figure 4: Question asking the difficulty of hearing ability.

Notwithstanding the questions about deafness, hearing trouble, tinnitus, and the use of hearing aid were also surveyed, only the responses of hearing difficulty (Figure 4) is analysed in this paper.

3. RESULTS

3.1. Demographic factors

A total of 502 and 145 and 519 responses were obtained in Survey 1, Survey 2, and Survey 3, respectively. The demographic data of the survey respondents are summarized in Table 2. In three surveys, the proportion of women is slightly higher than men. Respondents aged over 60 years old accounted for 18% , 29%, and 10% of the total number of respondents in three surveys, respectively. These obtained proportions are consistent with the characteristics of the young population (less than 60 years old) of the Vietnam Census in 2019.

Table 2: The demographic data of the surveyed respondents

		Survey 1	**Survey 2**	**Survey 3**	**Vietnam Census (2019)***
Number of respondents		502	145	519	
Response rate (%)		60.3	28.9	68.6	
Gender	Male	46.2	46.5	49.2	49.9
	Female	53.8	53.5	50.8	50.1
Age	<60 years old	81.9	70.6	89.9	88.1
	≥60 years old	18.1	29.4	10.1	11.9
Length of residence	0-5 years	51.1	27.7	40.0	
	Above 5 years	48.9	72.3	60.0	
Occupation	Employment	53.6	37.4	40.0	55.5
	Student, housewife, retired, unemployed	46.4	62.6	60.0	44.5

(*): General Statistics Office in Vietnam, "Statistical Date" http://www.gso.gov.vn/default.aspx?tabid=732

3.2. Change in numbers of flight events and noise levels

Table 3 shows the average number of daily flight events at TSN Airport in all three surveys. The daily number of flights operated at TSN Airport decreased by 43% in Survey 2 and 59% in Survey 3, compared to Survey 1. There is no difference in the number of night flights between Survey 2 and Survey 3, while the number of daytime flights in Survey 2 was 1.5 times more than Survey 3.

Table 3: Average number of flight events.

Time Period	**Operation Modes**	**Survey 1**	**Survey 2**	**Survey 3**
Day (6:00–18:00)	Arrival	214	140	86
	Departure	244	166	121
	Total	458	306	207
Evening (18:00–22:00)	Arrival	73	45	35
	Departure	64	23	20
	Total	137	68	55
Night (22:00–6:00)	Arrival	77	20	19
	Departure	56	19	18
	Total	133	39	37
All day	Arrival	364	205	140
	Departure	364	208	159
	Total	728	413	299

Sites 5 and 6, which are closest to TSN airport under arrival and departure routes, had the highest noise levels, as shown in Table 4. During the pandemic, the day-evening-night-weighted sound pressure levels (L_{den}) and the night-time equivalent continuous sound pressure levels (L_{night}) have decreased sharply. L_{den} in Survey 3 are lower than in Survey 2 due to the reduced number of flight events in day and evening. In contrast, L_{night} was not significantly different between the two surveys.

Table 4: Estimated noise levels at each survey site

Site	L_{den}[a]			L_{night}[b]			ΔL_{den}		ΔL_{night}	
	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 2	Survey 3	Survey 2	Survey 3
1	65.5	60.7	59.8	57.9	51.5	52.0	-4.8	-5.7	-6.3	-5.9
2	64.3	61.1	60.9	56.5	51.9	53.1	-3.2	-3.4	-4.6	-3.4
3	63.6	60.0	59.0	55.9	50.8	51.2	-3.6	-4.6	-5.1	-4.7
4	62.2	57.3	56.5	54.5	48.1	48.7	-4.9	-5.8	-6.4	-5.8
5	80.7	76.0	73.4	73.4	66.9	65.8	-4.7	-7.4	-6.5	-7.6
6	74.5	70.5	69.0	67.0	61.4	60.7	-4.0	-5.5	-5.6	-6.2
7	69.0	64.8	64.2	61.1	55.7	55.9	-4.2	-4.8	-5.4	-5.2
8	66.0	61.7	61.7	58.2	52.7	53.7	-4.3	-4.3	-5.5	-4.5
9	63.8	58.9	59.6	56.8	49.8	51.6	-4.9	-4.2	-7.0	-5.2
10	66.8	62.1	65.0	59.2	53.5	57.2	-4.6	-1.8	-5.7	-1.9
11	47.3	42.8	43.1	39.7	34.1	35.5	-4.5	-4.2	-5.6	-4.2
12	45.3	41.2	41.2	37.7	32.5	33.6	-4.1	-4.1	-5.3	-4.1

[a] Day-evening-night-weighted sound pressure level

[b] Night-time equivalent continuous sound pressure level

3.3. Residents' health status

Table 5 shows the percentage of respondents who had depressive symptoms, malaise, and hearing difficulty in three surveys. The percentage of respondents with depression, malaise, and hearing difficulties was 39.7%, 29.0%, and 40.4% in Survey 1. These numbers are 37.9%, 34.3%, and 33.1% in Survey 2, and 8.4%, 9.2%, and 5.3% in Survey 3. Multiple logistic regression analysis was conducted to determine the change in these health outcomes associated with noise exposure under the moderating effects of nonacoustic factors listed in Table 6. Each health outcome's model was firstly constructed by including L_{den}, survey, sex, and age factors as independent variables. Then, other nonacoustic factors that had a significant relationship with one of the health outcomes when analyzed in the logistic function with the corresponding outcome were included.

Table 5: Percentages of Depression, Malaise and Difficult in Hearing

Site	%Depression			%Malaise			%Difficulty in hearing		
	Survey 1	**Survey 2**	**Survey 3**	**Survey 1**	**Survey 2**	**Survey 3**	**Survey 1**	**Survey 2**	**Survey 3**
1	42.9	60.0	57.1	57.1	60.0	20.0	8.2	0.0	2.0
2	34.2	0.0	11.4	58.1	0.0	8.6	2.3	0.0	2.9
3	80.6	50.0	19.2	58.1	75.0	37.0	22.6	20.0	24.4
4	32.0	50.0	75.0	42.9	42.9	55.8	4.0	20.0	0.0
5	22.6	40.0	76.3	6.5	30.0	55.3	6.1	33.3	2.6
6	50.0	0.0	12.2	40.0	15.4	42.9	12.0	0.0	2.4
7	24.0	26.1	0.0	14.3	39.1	30.0	6.4	0.0	0.0
8	14.3	28.6	55.1	11.1	28.6	28.0	5.7	0.0	4.1
9	58.1	57.1	54.0	39.5	57.1	46.0	4.4	28.6	14.0
10	63.9	0.0	19.4	53.8	16.7	12.1	12.8	0.0	3.0
11	25.0	0.0	17.9	34.5	13.3	40.0	7.1	0.0	0.0
12	25.9	0.0	56.3	28.6	50.0	18.8	14.3	0.0	4.2
Total	39.7	29.0	40.4	37.9	34.3	33.1	8.4	9.2	5.3

3.4. Nonacoustic variables

Table 6 shows nonacoustic factors, including residential, personal and attitudinal, and health factors investigated in the questionnaire surveys. Factors related to living conditions such as education, income, or housing were investigated and considered adjustment factors of the health outcomes. The distribution frequencies in each category of these factors were counted. **t-Test** was performed to test whether or not there is a statistically significant difference in the means of these factors between the two surveys (between Survey 1 and Survey 2, between Survey 1 and Survey 3). A significant difference was observed with housing type, housing structure, type of frame of living room windows and doors, type of frame of bedroom windows and doors, age, residential area preference and quality, the opening of bedrooms' windows, number of hours of staying at home, stress, morbidity, alcohol intake, doing exercise frequency.

Table 6: Comparisons of nonacoustic factors obtained in the three surveys.

Nonacoustic factors	Categories	Survey 1	Survey 2	*p*-Value	Survey 3	*p*-Value
Residential factors						
Housing type	Self-owning	64.9 (321/495)	76.9 (110/143)	0.0015**	78.4 (407/519)	<.0001**
Floor Area/Width of the house	≤50 m^2	59.1 (269/455)	65.9 (89/135)	0.7515	66.2 (129/195)	0.0467*
Housing structure	1. Wooden	2.1 (7/337)	0 (0/92)	0.0467*	0.8 (4/495)	0.4363
	2. Bricks	14.5 (49/337)	7.6 (7/92)		25.1 (124/495)	
	3. Prefabricated	0.3 (1/337)	0 (0/92)		0.6 (3/495)	
	4. Reinforced concrete	44.8 (151/337)	52.2 (48/92)		20.4 (101/495)	
	5. Reinforced concrete with brick wall	34.4 (116/337)	37 (34/92)		53.1 (263/495)	
	6. Others	3.9 (13/337)	3.3 (3/92)		0.0 (0/495)	
Number of living room's glass layers windows and doors	1. More than 3 layers	2.7 (13/490)	1.4 (2/140)	0.6218	3.3 (16/489)	0.7029
	2. 2 layers	18.2 (89/490)	19.3 (27/140)		18.6 (91/489)	
	3. 1 layer	75.3 (369/490)	74.3 (104/140)		71.8 (351/489)	
	4. Others (the window has no glass)	3.9 (19/490)	5 (7/140)		6.1 (30/489)	
Type of frame of living room windows and doors	1. Aluminum frame	31.7 (156/492)	24.8 (35/141)	0.0050**	42.2 (213/505)	<.0001**
	2. Wooden frame	14.2 (70/492)	7.1 (10/141)		16 (81/505)	
	3. Plastic frame	1.4 (7/492)	0 (0/141)		1.4 (7/505)	
	4. Others	52.6 (259/492)	68.1 (96/141)		40.4 (204/505)	
Number of glass layers of bedroom windows and doors	1. More than 3 layers	1.2 (6/488)	37 (51/138)	0.2147	57.2 (214/374)	<.0001**
	2. 2 layers	13.5 (66/488)	6.5 (9/138)		16.6 (62/374)	
	3. 1 layer	77.7 (379/488)	0 (0/138)		1.9 (7/374)	
	4. Others (the window has no glass)	7.6 (37/488)	56.5 (78/138)		24.3 (91/374)	
Type of frame of bedroom windows and doors	1. Aluminum frame	37.3 (181/485)	0 (0/139)	<.0001**	2.2 (8/363)	<.0001**
	2. Wooden frame	20.0 (97/485)	12.9 (18/139)		25.1 (91/363)	
	3. Plastic frame	2.7 (13/485)	77.7 (108/139)		64.2 (233/363)	
	4. Others	40.0 (194/485)	9.4 (13/139)		8.5 (31/363)	
Personal and attitudinal factors						
Sex	Male	46.2 (229/496)	46.5 (66/142)	0.9301	49.2 (255/518)	0.2994
Age	≥60 years old	18.1 (90/498)	29.4 (30/102)	0.0022**	10.1 (52/517)	<.0001**
Residence length	≤5 years	41.7 (204/489)	27.7 (39/141)	0.0057**	40.0 (204/510)	0.8851
Residential area preference and quality (% Bad and Extremely bad)	1 Green	12.3 (60/487)	4.9 (7/143)	0.0174*	21.4 (110/515)	0.0105*
	2 Street Sceneries	7.9 (38/483)	3.5 (5/143)	0.0213*	16.7 (83/498)	0.0005**
	3 View	8.0 (39/485)	7 (10/143)	0.4603	16.1 (80/498)	0.0346
	4 Quietness	9.0 (43/478)	21.1 (30/142)	0.0144*	9.0 (45/502)	<.0001**
	5 Work convenience	3.8 (18/475)	1.4 (2/142)	0.8063	2.0 (10/495)	0.0342
	6 Education convenience	1.9 (9/478)	2.8 (4/143)	0.4020	2.0 (10/500)	<.0001**
	7 Health care convenience	3.4 (16/477)	1.4 (2/143)	0.3665	2.8 (14/501)	0.0006**
	8 Daily life service convenience	1.3 (6/477)	0.7 (1/143)	0.1331	2.0 (10/498)	<.0001**
	9 Transport convenience	4.4 (21/478)	10.5 (15/143)	0.0044**	6.6 (33/501)	<.0001**
Opening of bedrooms' windows (%Often and Always)	1. Dry season	31.2 (140/449)	15.9 (20/126)	<.0001**	45.1 (233/517)	<.0001**
	2. Rainy season	17.9 (81/452)			32.5 (166/510)	<.0001**

Sensitivity (%Very and Extremely)	1. Cold	2.9 (14/480)	1.6 (2/124)	0.4278	2.2 (11/491)	0.0005**
	2. Heat	15.6 (75/482)	17.5 (22/126)	0.6934	36.7 (177/482)	<.0001**
	3. Noise	16.1 (78/483)	14.3 (20/140)	0.3094	13.7 (67/488)	<.0001**
	4. Vibration	8.5 (41/482)	10.9 (15/138)	0.5248	6.6 (31/472)	0.4345
	5. Chemicals	5.4 (26/480)	0.8 (1/122)	0.9849	3.4 (16/475)	0.0013**
	6. Odors	8.8 (42/480)	8.9 (11/123)	0.2981	12.9 (62/479)	<.0001**
	7. Dust, pollen, polluted air	6.7 (32/481)	5 (8/161)	0.9758	2.6 (12/467)	0.0062**
Job	1. Employed	53.6 (266/496)	37.4 (52/139)	<.0001*	40.0 (207/517)	<.0001**
	2. Student	9.3 (46/496)	0 (0/139)		4.3 (22/517)	
	3. Homemaker	13.1 (65/496)	4.3 (6/139)		16.2 (84/517)	
	4. Retired	9.7 (48/496)	15.8 (22/139)		6.8 (35/517)	
	5. Unemployed	14.3 (71/496)	13.7 (19/139)		32.7 (169/517)	
Number of hours of staying at home	1. Under 8 h	30.6 (149/487)	7.7 (11/143)	<.0001**	14.2 (72/507)	0.0497*
	2. From 8 to 15 h	36.6 (178/487)	41.3 (59/143)		60.6 (307/507)	
	3. Above 15 h	32.6 (159/487)	50.3 (72/143		24.9 (126/507)	
Life satisfaction	Very dissatisfied	1.0 (5/492)	4.2 (6/142)	0.3765	0.8 (4/513)	<.0001**
Health factors						
Self-rated health status	Fair or Poor	23.6 (115/488)	25.9 (37/143)	0.4229	9.3 (47/506)	<.0001**
Stress	Quite a bit or Extremely stressful	0.2 (1/488)	3.5 (5/142)	0.0005**	5.6 (28/500)	<.0001**
Morbidity	1. Heart trouble	5.5 (24/439)	7.0 (9/129)	0.0195**	1.4 (7/504)	<.0001**
	2. High blood pressure or Hypertension	8.4 (37/439)	20.1 (27/134)		9.7 (49/506)	
	3. Hyperlipidemia	4.3 (19/439)	3.0 (4/133)		0.4 (2/505)	
	4. Stroke, small stroke or TIA	0.2 (1/439)	1.5 (2/134)		0.0 (0/506)	
	5. Asthma	0.7 (3/439)	0.0 (0/134)		0.6 (3/506)	
	6. Diabetes	3.9 (17/439)	7.5 (10/134)		3.0 (15/506)	
	7. Cancer	0.2 (1/439)	0.0 (0/134)		0.0 (0/505)	
	8. Depression or Neurosis	0.5 (2/439)	0.7 (1/134)		0.0 (0/506)	
	9. Others	8.7 (38/439)	8.2 (11/134)		0.8 (4/506)	
Salt intake	Very much	4.6 (22/474)	5.0 (7/139)	0.0671	3.1 (13/417)	0.1631
Awareness of nutrition balance	Do not think	12.7 (61/482)	16.4 (23/140)	0.8462	10.3 (51/497)	0.3759
Alcohol intake	Almost everyday	1.6 (8/494)	1.4 (2/144)	0.0316*	1.6 (8/503)	<.0001**
Smoking habit	Smoking	13.6 (67/491)	15.3 (22/144)	0.4340	18.6 (93/499)	0.0060**
Exercise frequency	Above 4 times a week	37.0 (182/492)	56.0 (79/141)	0.0004**	32.1 (161/501)	0.0090**
Body Mass Index	Obesity (BMI>29)	2.3 (11/485)	3.5 (3/86)		1.0 (5/504)	

* $p<0.05$, ** $p<0.01$

3.5. Depression

In this study, respondents are identified to have no significant clinical signs of depression (clinical significance) when having a total CESD-R score under 16 across all 20 questions, referring the instruction in Reference 11. The scores for each response in one question are: “Not at all or less than one day” =0; “1-2 days”=1; “3-4 days”=2; “5-7 days”=3; and “Nearly every day for two weeks”=4. There are five categories of possible depressive symptom determined as below:

- Meets criteria for Major depressive episode: Anhedonia or dysphoria nearly every day for the past two weeks, plus symptoms in an additional 4 DSM symptom groups noted as occurring nearly every day for the past two weeks;
- Probable major depressive episode: Anhedonia or dysphoria nearly every day for the past two weeks, plus symptoms in an additional 3 DSM symptom groups reported as occurring either nearly every day for the past two weeks or 5-7 days in the past week;
- Possible major depressive episode: Anhedonia or dysphoria nearly every day for the past two weeks, plus symptoms in an additional two other DSM symptom groups reported as occurring either nearly every day for the past two weeks or 5-7 days in the past week;
- Subthreshold depression symptoms: People who have a CESD-style score of at least 16 but do not meet the above criteria;
- No clinical significance: People who have a total CESD-style score less than 16 across all 20 questions.

Table 7 show the multiple logistic regression model constructed for the depression adjusted by L_{den} and nonacoustic factors. No significant associations were found between L_{den} and depression. The percentages of residents who had no clinical significance in three surveys are 60.3%, 71.0%, and 59.6%. A significant correlation of depression with heat sensitivity and “morbidity” was found.

Table 7: The multiple logistic regression for Depression
(Nagelkerke R^2=0.1282, AIC=1107.01, AUC=0.663)

Term		Estimate	Std Error	*p*-Value	Odds ratio	Lower 95%	Upper 95%
Intercept		-1.164	0.568	0.0405*			
L_{den}		0.002	0.008	0.8474	1.002	0.985	1.018
Survey	Survey 1				1		
	Survey 2	-0.265	0.293	0.3668	0.768	0.432	1.364
	Survey 3			0.7222	1.063	0.759	1.487
Sex	Male				1		
	Female	0.219	0.147	0.1369	1.245	0.933	1.662
Age	<60 years old				1		
	≥60 years old	0.190	0.220	0.3874	1.209	0.786	1.860
Quietness around the house	Good				1		
	Bad	0.305	0.252	0.2269	1.357	0.827	2.225
Heat	Insensitive				1		
	Sensitive	0.982	0.172	<.0001*	2.670	1.905	3.743
Noise	Insensitive				1		
	Sensitive	0.085	0.269	0.7524	1.088	0.643	1.843
Vibration	Insensitive				1		
	Sensitive	0.725	0.388	0.0613	1.695	0.851	3.377
Dust	Insensitive				1		
	Sensitive	0.528	0.352	0.1333	1.395	0.676	2.880
Self-rated health	Good				1		
	Bad	0.287	0.224	0.2003	1.332	0.859	2.065
Morbidity	Positive				1		
	Negative	0.747	0.200	0.0002*	2.111	1.426	3.125

3.6. Malaise

The response values for each question are: “Yes”=1, “Sometimes”=2, and “No”=3. The percentage of malaise was calculated by percentile distribution of the score rated by the surveyed population. The dummy variables were obtained from the following five quintiles of the scale: D1, D2, D3, D4, and D5 corresponded to 80-100, 60-79, 40-59, 20-39, and 0-19 percentile classes, respectively [8]. Then, D1 and D2 were identified as those who have malaise condition. Table 8 shows the multiple logistic regression analysis with the malaise as health outcomes accounting for nonacoustic factors related to health. A significant correlation of malaise with "self-rated health" (p=0.0006) and "morbidity" (p=0.0005) was found.

Table 8: The multiple logistic regression for Malaise
(Nagelkerke R^2=0.0912, AIC=1104.41, AUC=0.638)

Term		**Estimate**	**Std Error**	***p*-Value**	**Odds ratio**	**Lower 95%**	**Upper 95%**
Intercept		-1.281	0.573	0.0255*			
L_{den}		0.005	0.008	0.5388	1.005	0.988	1.022
Survey	Survey 1				1		
	Survey 2	-0.153	0.292	0.5994	0.858	0.484	1.520
	Survey 3			0.5881	0.911	0.650	1.276
Sex	Male				1		
	Female	-0.026	0.148	0.8591	0.974	0.729	1.302
Age	<60 years old				1		
	≥60 years old	0.057	0.220	0.7942	1.059	0.688	1.628
Quietness around the house	Good				1		
	Bad	0.142	0.253	0.5742	1.152	0.703	1.890
Heat	Insensitive				1		
	Sensitive	0.324	0.174	0.0622	1.382	0.984	1.943
Noise	Insensitive				1		
	Sensitive	0.307	0.267	0.2505	1.360	0.805	2.296
Vibration	Insensitive				1		
	Sensitive	0.052	0.344	0.8808	1.053	0.537	2.064
Dust	Insensitive				1		
	Sensitive	0.514	0.359	0.1522	1.672	0.827	3.377
Self-rated health	Good				1		
	Bad	0.738	0.215	0.0006*	2.091	1.372	3.189
Morbidity	Positive				1		
	Negative	0.677	0.195	0.0005*	1.969	1.342	2.887

3.7. Hearing ability

Table 9 shows the multiple logistic regression analysis for hearing ability as one of the health outcomes. The outcome of hearing ability was defined as the percentage of respondents who confirmed to "have difficulty in hearing and understanding words in normal conversation (even with a hearing aid)."

Table 9: The multiple logistic regression for Hearing Difficulty
(Nagelkerke R^2=0.2627, AIC=234.13, AUC=0.841)

Term		**Estimate**	**Std Error**	***p*-Value**	**Odds ratio**	**Lower 95%**	**Upper 95%**
Intercept		-6.091	1.629	0.0002*			
L_{den}		-0.002	0.022	0.9268	0.998	0.955	1.043
Survey	Survey 1				1		
	Survey 2	2.366	0.629	0.0002*	10.651	3.105	36.533
	Survey 3			0.0156*	4.641	1.337	16.104
Sex	Male				1		
	Female	1.263	0.444	0.0044*	3.535	1.482	8.434
Age	<60 years old				1		
	≥60 years old	0.965	0.462	0.0368*	2.624	1.061	6.491
Quietness around the house	Good				1		
	Bad	0.688	0.511	0.1784	1.990	0.730	5.422
Heat	Insensitive				1		
	Sensitive	0.015	0.445	0.9738	1.015	0.425	2.425
Noise	Insensitive				1		
	Sensitive	-0.047	0.764	0.9508	0.954	0.214	4.261
Vibration	Insensitive				1		
	Sensitive	0.124	0.871	0.8865	1.132	0.205	6.246
Dust	Insensitive				1		
	Sensitive	0.817	0.852	0.3375	2.264	0.426	12.020
Self-rated health	Good				1		
	Bad	1.429	0.482	0.0030*	4.173	1.622	10.731
Morbidity	Positive				1		
	Negative	0.685	0.474	0.1482	1.984	0.784	5.023

A statistically significant relationship between hearing ability with nonacoustic factors such as survey, sex, age, and self-rated health was found. Noise levels were not significantly associated with hearing ability in the models accounting for nonacoustic factors.

4. CONCLUSIONS

We investigated the change effect of aircraft noise on the self-reported health status of the residents who lived around TSN Airport in the period from August 2019 to September 2020. The noise levels around TSN decreased considerably when the flight operation was cut down during the coronavirus pandemic. However, the trend of the health situation of the residents near TSN was various. An improvement in health due to the reduction of noise could not be observed. Although aircraft noise was found to be an essential predictor of annoyance reaction of the residents living near TSN [20], it was not significantly associated with all three self-reported health outcomes investigated in this study. Nonacoustic factors such as heat sensitivity and morbidity were found to moderate the prevalence of depression. Self-rated health and morbidity significantly affected the prevalence of malaise. Sex, age, and self-rated health were associated with hearing ability. A similar study on the health effect of road traffic noise in Bulgaria concluded that higher noise exposure was associated with worse mental health only indirectly and indicated independent indirect paths through noise annoyance, social cohesion, and physical activity [21]. In the further step of this study, we would like to determine the structure of the impact of aircraft noise on the residents' physical and mental health concerning nonacoustic factors.

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