

Impact of COVID-19 Outbreak on the Level of Worry and Its Association to Modified Active Mobility Behaviour among Australian Children: A Cross-Sectional National Study [†]

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Abstract: The impact of the COVID-19 pandemic on the physical health of children is limited. However, the changes in life behaviour imposed to contain its spread may have prolonged lifelong impact, particularly on vulnerable child populations. These potential harms can be mitigated, but require identification of those most at risk. This paper aims to analyze the spatial disparity of the impact COVID-19 outbreak placed on parents and their primary school-age children's (grades 4–6) levels of worry. We conducted a national online survey sampling of parents and their children across five Australian states. Participants were recruited using social media for western Australia and a research company for the remaining states. Postal code, socio-demographics, exposures to COVID-19 cases, amount and frequency of following the news before and during the pandemic outbreak were captured. Univariate, bivariate and multivariate spatial statistical analyses were performed. Parents' level of worry related to COVID-19 is significantly associated with parents' amount and frequency of following COVID-19 news. It is critical to convey urgent information for public health awareness during health crises such as COVID-19. However, limiting the amount of exposure time towards unneeded media news may reduce population anxiety.

Keywords: COVID-19 outbreak-related worry; parents and primary school-aged children; time and frequency of parents' exposure to media; geospatial analysis



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1. Introduction

Over the last hundred years, a range of viral threats emerged and affected humans across the globe [1]. However, population groups most affected in the current pandemic is unlike previous events, e.g., the Spanish or Asian flu. In the recent outbreak, the older population were at higher risk of infection than young people. Nevertheless, the impact of the COVID-19 outbreak on children expands beyond the immediate health grief, to unprecedented social, mental and active behavioural consequences [2]. Previous research showed that high levels of exposure to the media has led to increased psychological distress across the population during health crises (e.g., Ebola and H1N1) [2], the post-Ebola pandemic or traumatic events, such as 9/11 across the U.S. [3] and the Boston Marathon bombing incident [4,5]. It is critical to communicate necessary information to the public to seek appropriate health-protective public behaviour. However, it is likely that repetitive exposure to news can heighten the perceived risk of health-related topics [2] even for people who may not experience events directly.

The recent outbreak of COVID-19 saw cases first detected in central China in December 2019. By late January 2020, health authorities in Australia had confirmed the first case in

Victoria [6]. By 28 November 2020, the Department of Health (DoH) confirmed 27,885 cases nationwide [6]. However, within Australia, the severity in terms of both the number of cases spread in a short time and morbidity has varied across jurisdictions. A higher number of cases were found in the eastern part of Australia including New South Wales (NSW) and Victoria (VIC) than in other states, e.g., South Australia (S.A.), Queensland (QLD) and Western Australia (W.A.) [6]. Victoria and New South Wales have an overwhelming 75% of the total number of cases, and 90% of fatalities were from Victoria [6]. Important information was regularly disseminated through official health entities such as the World Health Organization (WHO) and the Department of Health. Nevertheless, the impact of repetitive and extended exposure of parents and their children to related pandemic news, via various media and television, on heightened parents and children anxiety across the states is yet to be fully explored.

This study is unique in using spatial technology to answer public health concerns during and after the recent pandemic outbreak. Specific to this paper, we first address the research question regarding the association between exposures to COVID-19 related news and parents' and their primary school-aged children's (grade 4–6) level of worry amid a health pandemic. Second, we explore whether parents' level of worry is associated with the number of cases across jurisdiction areas. The output should inform health interventions or promote appropriate strategies in the current pandemic or the future.

2. Methods

2.1. Data

Epidemiological data: Shapefiles layers with the number of COVID-19 cases for each of Victoria and New South Wales jurisdictions were downloaded from the Australian COVID-19 GIS hub.

Socio-demographic data: Parents responded to questions related to gender, education, age, income, postal code, ethnicity background and the child's gender.

Measures of parents' and children's worry: Prior current pandemic history of worry of parents and children questions were adapted from earlier questionnaires on pandemics, e.g., Ebola or traumatic crises [3,7,8]. Parents answered questions using a 4-point scale of 1 'not at all' to 4 'nearly every day', on parents' history of anxiety, depression levels, children's history of interest in playing or experiencing any level of worry. We adapted the survey carried by Thompson et al. in their study assessing people's worry from the Ebola pandemic [3]. We also captured participants' (parents') recent direct or indirect exposure to COVID-19 through family, friends or the community. Finally, parents' and children's worry related to the COVID-19 outbreak using a scale from 1 'never' to 6 'very worried all the time' was captured.

Habits of following news prior and during the pandemic: Respondents (parents and children) reported their habit of following news in terms of frequency and duration from sources such as television, radio, internet, social media, newspaper, etc., before and during the outbreak. We used a scale from 1 as 'never' to 8 of 'more than 6 h every day'.

Habits of consumed screen time prior and during COVID 19: Parents assessed their child's use of digital tools (e.g., smartphones, iPads, computers, T.V., electronic games), adopting the same scale noted above. In turn, children answered similar questions offering evaluation of parents to children differences in their assessment of time recorded.

Prior and during the COVID-19 outbreak children's active mobility behaviour: Parents and children together reported temporal (weekdays and on weekends of during and before the pandemic) and spatial (extent of distance), of two separate weeks, children's various shapes of active mobility behaviour (indoor or outdoor).

Health Index: Height and weight to derive Body Mass Index (BMI) was reported by parents, asking for the latest measures known.

2.2. Workflow of the Survey

University Ethics committee reviewed survey procedures and questionnaires. After approval, we successfully conducted a pilot testing of the survey that was built online using the Qualtrics engine, in May 2020. We sampled parents and children with different ethnic and educational backgrounds for the pilot testing. After that, we carried a cross-sectional online sample survey between June–July 2020 of parents and their children in grades 4–6. We recruited participants through social media (Facebook, Twitter, university portal) and via GrowthOps, a third-party research company. Participants' information aimed at briefing parents on the study's aim was followed by screening questions confirming parents carrying out the survey have children in the nominated grades. Before proceeding further, parents had to consent to complete the survey jointly with their children.

Areas of study: The survey covered samples from states with high severity numbers of COVID-19 cases, such as New South Wales and Victoria, and from lower number cases such as South Australia, Queensland and Western Australia.

2.3. Spatial Analysis

After data cleaning and applying data engineering procedures, using ArcGIS Pro 2.6.3, we joined tabular surveyed participants' information to the spatial layer of Local Government Areas (LGAs) via the common postal address field. To understand sample characteristics, we carried out univariate descriptive statistical analysis. To answer the first research question, we performed a sequence of steps. First, we carried out a scatter plot matrix that served as visual bivariate relationships assessment among research variables. Ten variables of parents age, gender, household income, ethnicity background, education, income change over the COVID-19, history of parents' worry or distress (anxious), direct exposures to COVID-19, amount of time and frequency of exposure to media (before and during COVID-19) on parents' levels of worry on children playing outdoor during COVID-19 were used. Regression equations calculated for every bivariate relationship in the scatter plot matrix and variables showing significant R-squared (R^2)—representing the strength of the relationship—were considered for further regression analysis. To answer research questions, we conducted linear regressions of exploratory regression, generalized linear regression (GLR), ordinary least squares analysis (OLS), spatial autocorrelation, hot spot analysis and group analysis.

3. Results and Discussion

3.1. Parent and Children's Characteristics

The geographical distribution of the 339 participants that fully completed the survey is portrayed in Figure 1. Respondents surveyed were from Victoria ($n = 102$; 30%), New South Wales ($n = 95$; 28%), South Australia ($n = 39$; 11%), Western Australia ($n = 65$; 20%) and Queensland ($n = 38$; 11%). Parents were 43% males and 56% females. Children surveyed were 44% females and 56% males. In the survey sample, 78% had not been exposed to COVID-19, 13% had direct exposures (been infected or in close connection with someone infected), and 9% knew someone who got infected. Parent's educational backgrounds were university graduate (38%), postgraduate (25%), senior high school (13%), holds a diploma (12%), technical (8%), and the remaining (2.4%) were less than high school. Surveying the impact of COVID-19 on people's job statuses showed that 30% had their salary reduced, 14.7% were seeking employment and 56% had the same job, yet nearly half carried out their job from home at the survey time. The proportion of participants that lived in a place without access to a backyard was 13%. Children were 35% in grade four, 36% in grade five and 29% in grade six.



Figure 1. Geographical distribution of participants across the five states, Australia. (Source of base map was ESRI, and red colour indicates participants' postal areas after joining survey data to postal areas of 2016 shapefiles downloaded from the Australia Bureau Statistic (ABS) data webpage.)

3.2. Parents' Exposures to Media Coverage and Correlation to the Level of Worry

Univariate bar chart analysis showed variation of measured parents' levels of worry across the states from before (Figure 2a) and during the COVID-19 outbreak (Figure 2b). The highest disparity depicted was of parents from NSW and Victoria compared to QLD, S.A. and W.A.

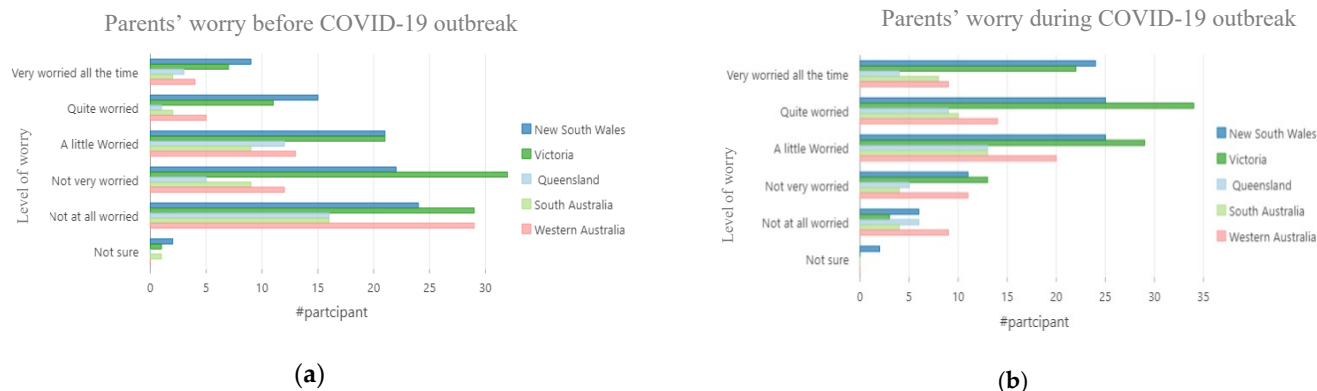


Figure 2. Parents' level of worry variation across five states in Australia: (a) level of parental worry before the pandemic; (b) level of parental worry during the COVID-19 outbreak.

Before COVID-19, parents reporting 'not being worried at all' on their children being out was 34%, with the highest being in Victoria and Western Australia ($n = 29$ for each; each 25% of total number of parents), followed by NSW ($n = 24$; 21%). During COVID-19, a decline to merely 8% was seen in parents reporting 'not worried at all', with one third (32%) being parents from W.A., followed by NSW and QLD with 21% each. Before the outbreak, parents reporting being 'very worried all the time' was only 7.5%, but increasing to 20% during the pandemic, with the highest percentage of the total found in NSW (35%) and Victoria (33%).

Parents' habit of consumed time following the news before and during the pandemic in Figure 3a,b depict a significant drop in parents that 'never followed the news', from a total of 8% before the outbreak to 1.2% amid the pandemic. There was an increase from less than 1% of parents consuming 'more than 6 hours' watching the news every day to

over 4% during the pandemic, and parents that consumed 1–3 h daily watching the news doubled from $n = 61$ (18%) to $n = 121$ (36%) during the pandemic.

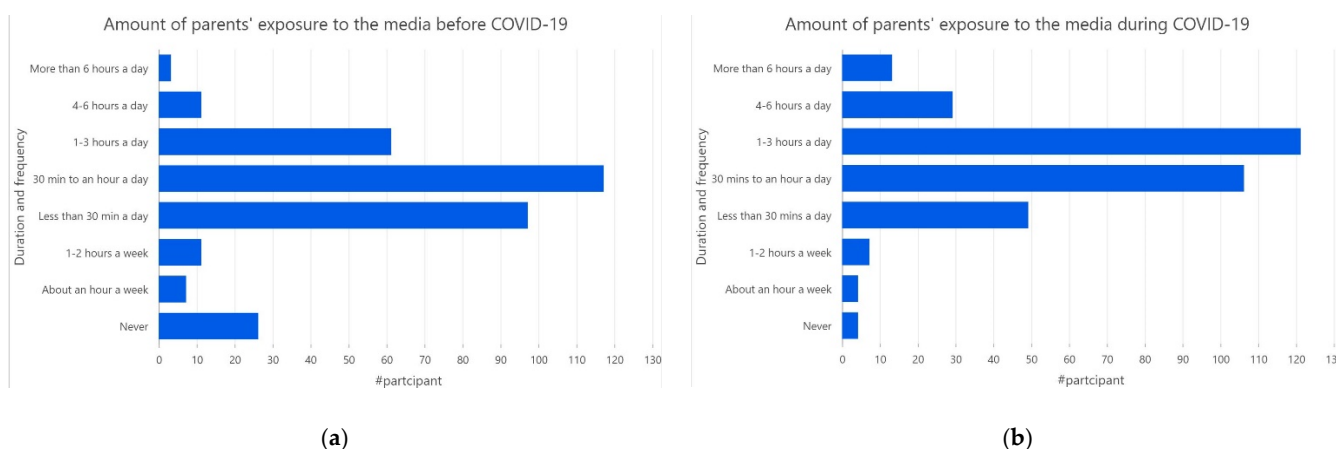


Figure 3. Parents' amount and frequency of exposure to news: (a) before the coronavirus outbreak; (b) during the coronavirus outbreak.

Children reporting the amount of time following the news before and during the pandemic has also portrayed longer hours and more frequency during the pandemic (Figure 4). However, variances were more notable in the lower and higher end of the scale. For example, children reporting to 'never' follow the news before the pandemic was $n = 70$ (21%), dropping to (6%) during the pandemic.

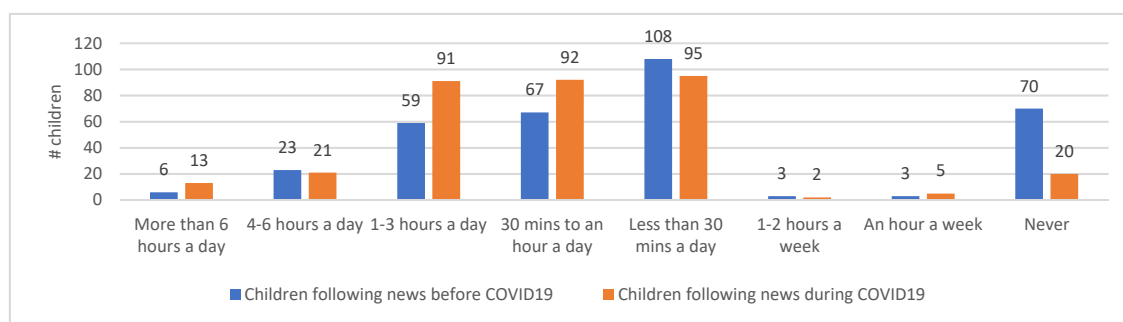


Figure 4. Children reporting consumed amount of time and frequency of following the news before and during the pandemic.

Variables that showed a significant relationship in the scatterplot matrix were child's gender, parents' education, parent experience of direct or indirect exposure to COVID-19, and parents' following news habits prior to and within the pandemic outbreak. Those variables were then used in the multivariate OLS regression analysis. The results (Table 1) depicted a significant association of parents' worry related to the COVID-19 outbreak with the consumed amount of exposure to the media.

We examined variables that were most likely to explain parents' habits of daily exposures to the news. The scatterplot matrix depicted variables that were most likely to explain parents' habits of long hours of exposure to media were used in a generalized linear regression (GLR) analysis [9]. The explanatory variables and output of analysis are illustrated in Table 2. The analysis depicted parents' increased hours of exposure to media was significantly ($p < 0.001$) associated with parents' levels of education, perceived safety before the pandemic, parents' history of controlling worry and worry related to the COVID-19 during the outbreak.

Table 1. Output of OLS identifying significance variables impacting parents' worry during the pandemic.

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Parents' direct exposure to COVID-19	0.173496	0.115020	1.508405	0.132435	0.101130	1.715585	0.087199	1.250086
Parents' perception of safety before COVID-19	0.019415	0.054351	0.357215	0.721175	0.061451	0.315947	0.752255	1.045090
Parents' ability to control worry	0.077366	0.082453	0.938302	0.348774	0.073236	1.056387	0.291568	1.288813
Parents following the news in media before COVID-19	−0.153906	0.262035	−0.587350	0.557380	0.178021	−0.864540	0.387916	1.098175
Parents following the news in media during COVID-19	0.145401	0.036053	4.032969	0.000075 *	0.035189	4.131950	0.000051 *	1.135791

Notes on Interpretation: [a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable. [b] Probability and robust probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant ($p < 0.01$). [c] Variance inflation factor (VIF): Large variance inflation factor (VIF) values (>7.5) indicate redundancy among explanatory variables.

Table 2. Output of GLR analysis examining determinants of parents worry in a pandemic.

Variables	Coefficient [a]	StdError	z-Statistic	Probability [b]	VIF [c]
Parents' gender	−0.028637	0.053690	−0.533384	0.593768	1.090314
Household income	0.005574	0.025652	0.217290	0.827983	1.071606
Parents' income change during COVID-19	0.018846	0.018661	1.009950	0.312519	1.009999
Living in place with backyard	0.023516	0.075866	0.309962	0.756590	1.007281
Parents' direct exposure to COVID-19	−0.044463	0.043935	−1.012010	0.311533	1.242509
Perception of safety before COVID-19	−0.047679	0.021654	−2.201846	0.027676 *	1.064312
Parents' level of worry on children playing during COVID-19	0.075110	0.022244	3.376706	0.000734 *	1.031549
Parents' history of controlling worry feeling	0.081566	0.030697	2.657105	0.007881 *	1.240850

Notes on Interpretation: * An asterisk next to a number indicates a statistically significant p-value ($p < 0.01$). [a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable. [b] Probability: Asterisk (*) indicates a coefficient is statistically significant ($p < 0.01$). [c] Variance inflation factor (VIF): Large variance inflation factor (VIF) values (>7.5) indicate redundancy among explanatory variables.

To answer the second research question of this paper, we carried out a spatial autocorrelation to detect the probability of spatial significance. In this analysis, we accept or reject a null hypothesis that parents' level of worry is spatially clustered "significant". The z-score of 0.372477 (Figure 5a) infers that parents' worry patterns do not appear to be

spatially significantly different than random; thus, we accept the null hypothesis of the spatial correlation. Conversely, we rejected the null hypothesis as highly significant spatial clustering of number of the cases in each postal code was found, Figure 5b.

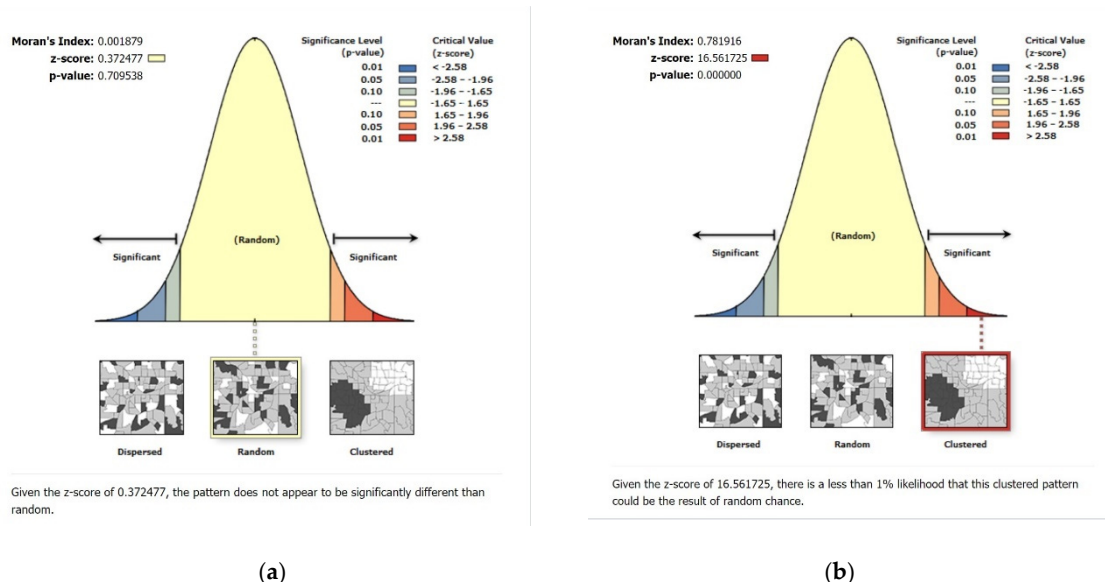


Figure 5. Output of spatial autocorrelation analysis on data for the state of Victoria. (a) We accept null spatial significance of parents' worry from the pandemic in Victoria; (b) We reject null spatial significance where Victoria's COVID-19 cases showed spatial clustering of COVID-19 cases.

Output of hot spot analysis (Getis-Ord Gi*) in Figure 6 illustrates the pattern of non-significant spatial clustering of parents' levels of worry related to COVID-19 (Figure 6a) and the high significance clustering of COVID-19 cases across the jurisdiction areas in Victoria (Figure 6b).

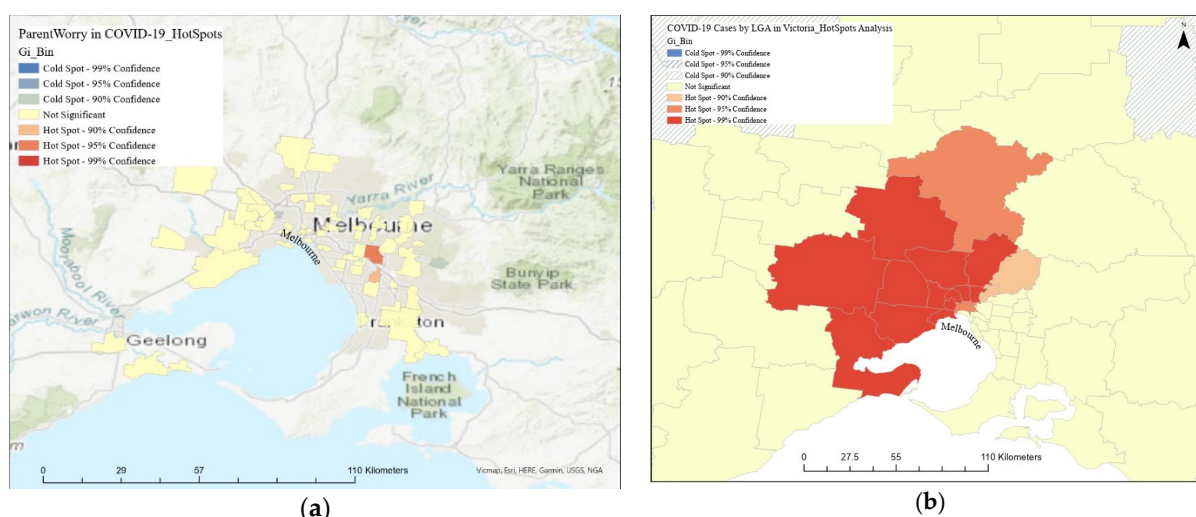


Figure 6. Output of hot spot analysis on data for the state of Victoria. (a) We accept null spatial significance of parents' worry related to COVID-19 in Victoria; (b) We reject null spatial significance where Victoria's COVID-19 cases showed spatial clustering of COVID-19 cases.

The initial findings specific to the aim defined for this paper suggest that extensive parents' exposures to the news amid the COVID-19 outbreak are a key indicator of negative psychological responses to health crisis portrayed by a higher level of parents' anxiety.

History of parents' frequent worry feelings and perception of safety before the outbreak were significant predictors of parents' longer hours of media exposure. Thirteen percent of parents reported direct exposures to COVID-19; however, over 77% of parents have expressed varying levels of worry, with 20% having higher acute stress. This suggests that the null hypothesis of parents' levels of worry spatial clustering may be explained by parents' levels of worry resulting from exposure to extended hours of related media, and not due to real case severity in the surroundings. The output of regressions analyses confirms the earlier research findings of traumatic events, such as bombing post-9/11 [10], the Boston bombing [5], or health crises such as post-Ebola [3], including the recent commentary paper by Garfin et al. [2]. Individuals' long exposures to traumatic events or health crises are likely contributing to people's heightened anxiety. Further sensitivity analysis will be carried out.

Additional analysis to examine other variables such as the correlation of open space presence to parents' or their children's levels of worry will be conducted. We will also assess the impact of the recent pandemic on modifying children's spatial and temporal physical activity.

4. Conclusions

In the present study, the national cross-sectional data surveyed during the COVID-19 outbreak between June–July 2020 was engineered in ArcGIS Pro to assess parents' and children's levels of worry during the recent coronavirus outbreak, and its correlation to potential variables. We found a strong significant positive association between parents' consumed times of exposure to media and their worry during the recent pandemic. Similarly, children were more frequently following the news during the social distancing. Although media coverage is critical to conveying crucial public health awareness, long and repetitive exposure to media, that may not provide additional important information to the public, can increase people's distress. Consequently, this will contribute to lowering people's overall mental and physical health capacity. Despite the research limitation of carrying out a cross-sectional survey, the study is among the few that provides timely evidence on the negative impact caused by the recent outbreak beyond immediate physical health, and which may inform post-pandemic children's health strategies.

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Conflicts of Interest: The authors declare no conflict of interest.

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