

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

Roula Zougheibe ^{1,*}, Richard Norman ², Ori Gudes ³ and Ashraf Dewan ¹

¹ School of Earth and Planetary Sciences, Curtin University; Kent Street, Bentley, Perth Western Australia, Australia 6102, roula.zougheibe@postgrad.curtin.edu.au, A.Dewan@curtin.edu.au

² School of Public Health, Curtin University, Kent Street, Bentley, Perth, Western Australia, Australia 6102; richard.norman@curtin.edu.au

³ School of Public Health and Community Medicine, UNSW Sydney NSW 2052, Australia; o.gudes@unsw.edu.au.

* Correspondence: roula.zougheibe@postgrad.curtin.edu.au

Abstract: The impact of the COVID-19 pandemic on 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 analysis were performed. Parents' level of worry related to COVID-19 is significantly associated with parents' amount and frequency following COVID-19 news. Parents' exposure to media coverage during the current public health crises contributed to heighten the level of anxiety that may have potential public health repercussions. 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 parents' and children's 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, the population groups most structure impacted 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 level of exposures to the media has led to increased psychological distress across the population during health crises (e.g., Ebola and H1N1) [2], post-Ebola pandemic or the 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 November 28th, 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 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 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 intervention or promote appropriate strategies to post the current pandemic or the future.

2. Methods

2.1. Data

Epidemiological data: Shapefiles layers with number of COVID-19 cases for each of Victoria and New South Wales jurisdiction 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 survey carried by Thompson et al. in their study assessing people worry from 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 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 term 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 hours 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 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 reported by parents 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 Qualtrics engine, in May 2020. We sampled parents and children with different ethnic and educational background for the pilot testing. After that, we carried a cross-sectional online sample survey between Jun – 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 the survey have children of 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 number of COVID-19 cases such as New South Wales, 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 univariate descriptive statistical analysis. To answer the first research question, we performed a sequence of steps. First, we carried 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' level of worry on children playing outdoor during COVID-19 were used. Regression equation calculated for every bivariate relationship in the scatter plot matrix and variables showing significant R-squared (R^2) -represents 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% female and 56% males. In the survey sample, 78% have not been exposed to COVID-19, 13% had direct exposures (been infected or in close relation with someone infected, and 9% knew someone who got infected). Parent's educational background were university graduate (38%), postgraduate (25%), senior high school (13%), holds a diploma (12%), technical (8%) and remaining (2.4%) were less than high school. Surveying impact of COVID-19 on people job status showed that 30% had their salary reduced, 14.7% were seeking employment with 56% have the same job yet nearly half carried 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 ESRI and red colour indicate participants' postal areas after joining survey data to postal areas of 2016 shapefiles downloaded from Australia Bureau Statistic (ABS) data webpage.

3.2. Parents exposures to media coverage and correlation to the level of worry

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

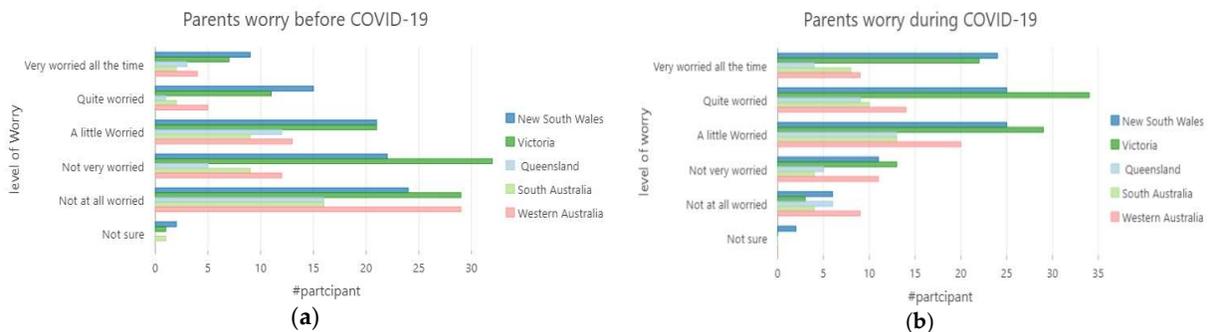


Figure 2. Parents' level of worry variation across five states in Australia: (a) level of parental worry before the pandemic; (b) level of parental worry during the COVID-19 outbreak.

Before COVID-19, parents reporting 'not being worried at all' on their children being out were 34% with the highest being the Victorian 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% in parents reported 'not worried at all' with one third (32%) are parents from W.A. followed by each NSW and QLD 21%. Before the outbreak, parents reported being 'very worried all the time' was only 7.5% increasing to 20% during the pandemic with the highest percentage of the total being from NSW 35% and 33% from VIC.

Parents' habit of consumed time following the news before and during the pandemic in Figure 3a and 3b bar charts depicted a significant drop in parents that 'never followed the news' of a total 8% before the outbreak to 1.2% amid the pandemic. An increase from less than 1% of parents consumed 'more than 6 hours' watching the news every day to over 4% during the pandemic with parents that consumed 1-3 hours daily watching the news doubling from n=61 (18%) to n=121 (36%) during the pandemic.

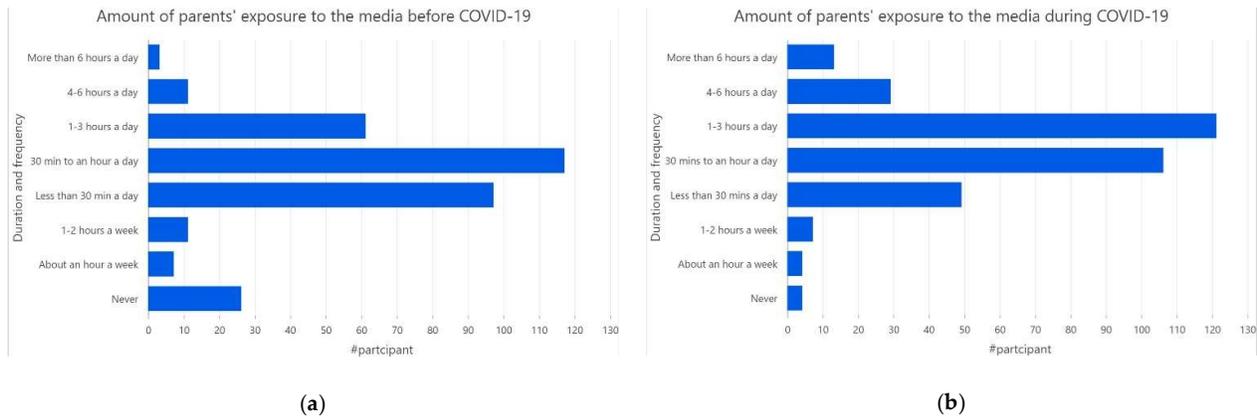


Figure 3. Parents' amount and frequency of exposure to news: (a) before the coronavirus outbreak; (b) during the coronavirus outbreak.

Children reported the amount of time following the news of 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 reported 'never' followed the news before the pandemic was n=70 (21%) dropping to (6%) during the pandemic.

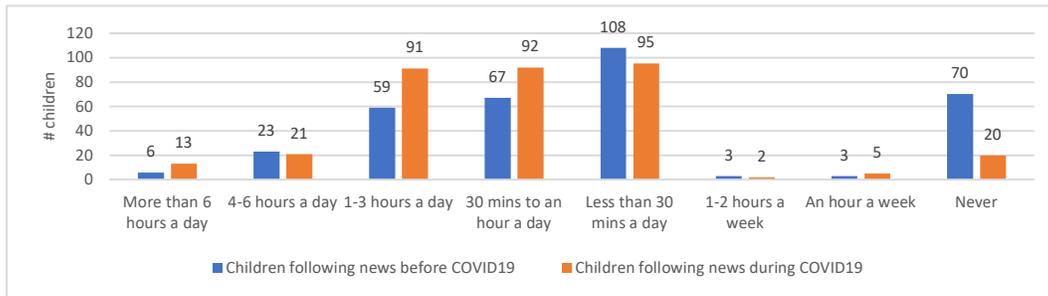


Figure 4. Children reported consumed amount of time and frequency of following the news of before and during the pandemic.

Variables that showed a significant relationship in the scatterplot matrix were; child's gender, parents' education, parent experience of direct or indirect exposure or to COVID-19, parents prior following news habits 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 COVID-19 outbreak with the consumed amount of exposure to the media.

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

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Ro-bust_SE	Ro-bust_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
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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. [d] Akaike's Information Criterion (AICc): Measures of model fit/performance.

We examined variables that were most likely to explain parents' habits of daily exposures to the news. The scatter plot matrix depicted variables that most likely to explain parents' habits of long hours of exposures to media that were used in generalized linear regression (GLR) analysis that model predictions of dependent variable in its relationship to a set of explanatory variables [9]. The explanatory variables and output of analysis are illustrated in Table 2. The analysis depicted parents increased hours of exposures to media was significantly ($p < .001$) associated with parent's level of education, perceived safety before the pandemic, parents history of controlling worry and worry related to the COVID-19 during the outbreak.

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

Variables	Coefficient [a]	StdError	z-Statistic	Probability [b]	VIF [C]
Parent's 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 back yard	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
Parent's 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 a spatial autocorrelation to detect the probability of spatial significance. In this analysis, we accept or reject a null hypothesis of parents' level of worry is spatially clustered "significant". The z-score of 0.372477, Figure 5a, infer that parents worry pattern does not appear to be spatially significantly different than random; thus, we accept the Null hypothesis of relationship. Conversely, we rejected the Null hypothesis as highly significant spatial clustering of number of cases in each postal code was showing in (Figure 5b).

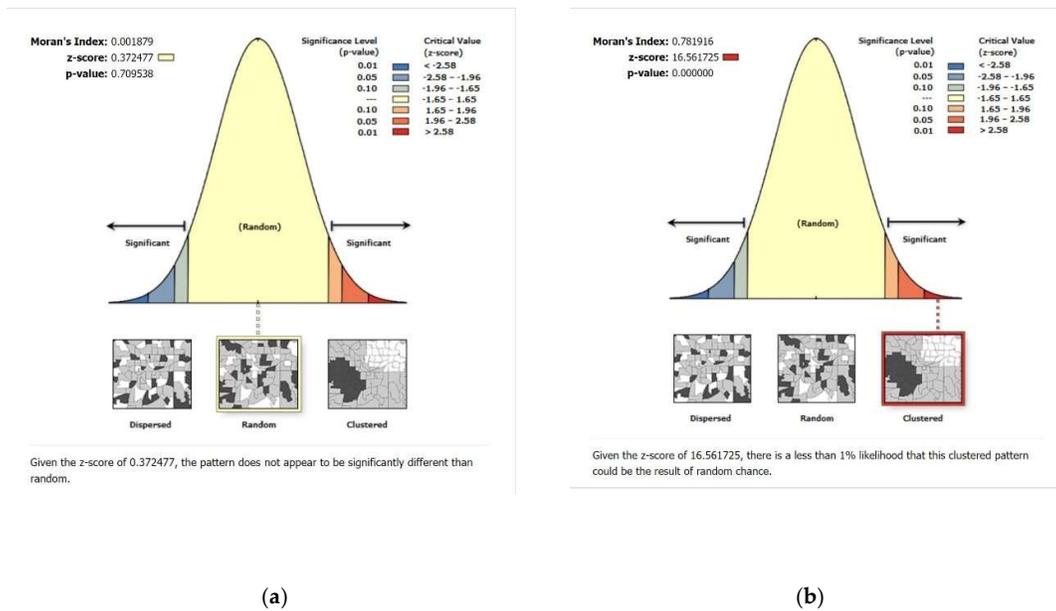


Figure 5. Output of spatial autocorrelation analysis on data for the state of Victoria. **a)** We accept Null spatial significance of parents' worry related COVID-19 in Victoria; **(b)** We reject Null spatial significant where Victoria's COVID-19 cases showed spatial clustering of COVID-19 cases.

Output of Hotspot analysis (Getis-Ord G_i^*) in Figure 6, illustrates the pattern of non-significant spatial clustering of parents level 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.

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 in a higher level of parents' anxiety.

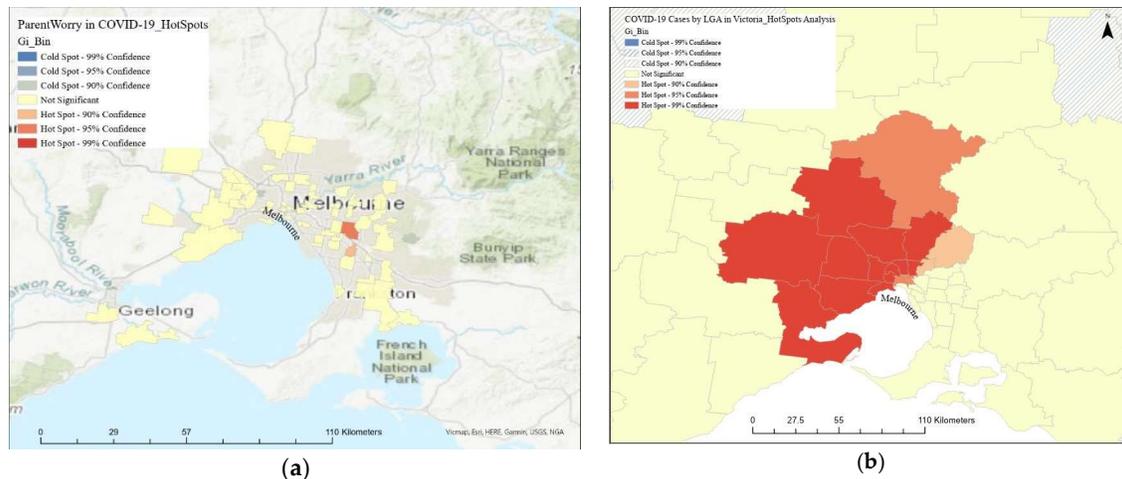


Figure 6. Output of Hot Spot analysis on data for the state of Victoria. **a)** We accept Null spatial significance of parents' worry related COVID-19 in Victoria; **(b)** We reject Null spatial significant where Victoria's COVID-19 cases showed spatial clustering of COVID-19 cases.

History of parents' frequent worry feeling and perception of safety before the outbreak were significant predictors to parents' longer hours of media exposures. Thirteen per cent of parents have reported direct exposures to COVID-19; however, over 77% of

parents have expressed varying levels of worry, with 20% are on higher acute stress. This suggests that the null hypothesis of parents' level of worry spatial clustering may be explained by parents' level of worry resulting from exposures to extended hours to related media and not due to real cases severity in the surroundings. The output of regressions analysis confirms earlier research findings on traumatic events as a result of bombing post the 9/11[10], Boston bombing[5], or health crisis such as post-EBOLA [3] including recent commentary paper by Garfin et al. paper [2]. Individuals' long exposures to traumatic events or health crises events are likely contributing to heightened people's anxiety. Further sensitivity analysis will be carried.

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

4. Conclusion

In the present study, the national cross-sectional data surveyed during the COVID-19 outbreak between Jun-July 2020 was engineered in ArcGIS Pro to assess parents and children level 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 exposures to media and psychological response in term of 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 lower people's overall mental and physical health capacity. Despite this research limitation of carrying cross-sectional survey, the study is among few that provides timely evidence on the negative impact caused by the recent outbreak beyond immediate physical health that may inform post-pandemic children health strategies. Children health providers such as Telethon kids institute may in turn play vital roles by communicating to parents and children factual information during the pandemic while mitigating potential harm on vulnerable children caused by high-level distress post the recent outbreak.

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Conflicts of Interest: The authors declare no conflict of interest

References

1. Bergquist, R.; Stengaard, A.-S. Covid-19: End of the beginning? *Geospatial Health* **2020**, *15*, doi:10.4081/gh.2020.897.
2. Garfin, D.R.; Silver, R.C.; Holman, E.A. The novel coronavirus (COVID-2019) outbreak: Amplification of public health consequences by media exposure. *Health Psychology* **2020**, *39*, 355-357, doi:10.1037/hea0000875.
3. Thompson, R.R.; Garfin, D.R.; Holman, E.A.; Silver, R.C. Distress, worry, and functioning following a global health crisis: A national study of Americans' responses to Ebola. *Clinical psychological science* **2017**, *5*, 513-521.
4. Holman, E.A.; Garfin, D.R.; Silver, R.C. Media's role in broadcasting acute stress following the Boston Marathon bombings. *Proceedings of the National Academy of Sciences* **2014**, *111*, 93-98, doi:10.1073/pnas.1316265110.

5. Garfin, D.R.; Holman, E.A.; Silver, R.C. Cumulative exposure to prior collective trauma and acute stress responses to the Boston Marathon bombings. *Psychological Science* **2015**, *26*, 675-683.
6. Department of Health. Coronavirus (COVID-19) current situation and case numbers. 24/11/2020 ed.; Australian Government: Department of Health, 2020.
7. Ware, J.E.; Sherbourne, C.D. The MOS 36-Item Short-Form Health Survey (SF-36): I. Conceptual Framework and Item Selection. *Medical Care* **1992**, *30*, 473-483.
8. RAND Health Care. 36-Item Short Form Survey Instrument (SF-36). Available online: https://www.rand.org/health-care/surveys_tools/mos/36-item-short-form/survey-instrument.html (accessed on 11/4/2020).
9. ESRI. ArcGIS Pro. Available online: <https://pro.arcgis.com/> (accessed on 14/12/2020).
10. Silver, R.C.; Holman, E.A.; Andersen, J.P.; Poulin, M.; McIntosh, D.N.; Gil-Rivas, V. Mental-and physical-health effects of acute exposure to media images of the September 11, 2001, attacks and the Iraq War. *Psychological Science* **2013**, *24*, 1623-1634.