ORIGINAL ARTICLE

Effects of varying pandemic restrictions on the health-related behaviours of Australian children

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Aim: To explore the effects of COVID-19 pandemic restrictions varying in severity and duration on health-related behaviours in children aged 5–17 years.

Methods: We used data from the Royal Children's Hospital National Child Health Poll, an online cross-sectional survey of Australian caregivers. The survey assessed 1222 caregivers' perceived changes in health-related behaviours (physical activity, sleep, screen-time, diet, outdoor activity, family and peer connectedness) of 2011 children aged 5–17 years in a typical week from June to September 2020 (when jurisdictions experienced varying restriction severity and duration) compared to retrospective reports of behaviour before March 2020 (pre-pandemic). To compare the effects of varying restriction severity in Victoria, New South Wales (NSW) and other states and territories on health-related behaviours binary logistic regression was used, adjusting for caregiver demographics and weighted to reflect Australia's parent population.

Results: Compared to pre-pandemic, Victoria's restrictions had a greater impact on child health-related behaviours compared to NSW restrictions and an even stronger impact compared to other states and territories which experienced few or no restrictions. A greater proportion of Victorian children reported more recreational screen time (71.3%) than NSW (53.9%) and other states and territories (34.5%) and less physical activity (57.2%) than NSW (30.3%) and other states and territories (26.5%). Victorian children reported less outdoor activity (62.6%) than NSW (32.0%) and other states and territories (25.2%), and less social connectedness (68.0%) than NSW (35.4%) and other states and territories (27.3%).

Conclusions: More severe and longer COVID-19 pandemic restrictions are associated with greater impacts and predominantly more negative impacts to children's health-related behaviours. These should be mitigated through policies and programs to encourage healthier life-styles.

Key words: caregivers; children; health-related behaviours; lockdown; parents; SARS COVID-19 pandemic.

What is already known on this topic	**What this paper adds**
1 Previous studies have established lockdowns have had an impact on children worldwide in regards to sleep, physical activity, diet, screen time and social connection.	1 This is the first study to investigate the differing effects of restrictions varying in severity and duration on a broad range of children's health-related behaviours.
2 This has concerning implications for the long-term effects of COVID-19 pandemic restrictions.	2 Our study provides clarity on the impacts of COVID-19 pandemic restrictions on diet and physical activity to redress discord in the literature.

Lockdowns were implemented world-wide as a public health measure to reduce transmission of the SARS-Coronanvirus-2 (henceforth COVID-19) and have resulted in unprecedented impacts on the life-style of families.[1–7] Following Australia's national lockdown (March to May 2020), restrictions differed across Australia due to varying transmission rates and state government responses. Victoria's lockdown from 8 July to 23 November 2020, featured measures including 'four reasons to leave home', exercise limits (1 h) and night-time curfews.[8] Comparatively, New South Wales (NSW) had minimal community transmission in July 2020 and employed less severe restrictions; with capacity limits on gatherings in the hospitality sector, events and inside homes.[9] Contrastingly, the remaining states and territories had no community transmission and only minor or no restrictions in place during this period.

Studies on the acute effects of lockdown on children's life-styles have predominantly focused on specific behaviours, such

as physical activity, screen time and sleep in adolescents and some discrepancy pervades the literature.[1–5] For instance, while Greek and Australian studies showed lockdowns decreased adolescents' physical activity,[1,3] a German study reported physical activity increased, despite the same loss of organised sporting activities.[4] The implications of decreased physical activity and increased recreational screen usage caused by lockdowns may be associated with poorer long-term health outcomes.[2,3,10] Investigating if increased sedentary behaviours, including screen use, are a direct impact of pandemic restrictions will help inform the public health intervention strategies.

Existing studies on children's behaviour changes due to restrictions compared before and after lockdown exposure without adequate control groups; therefore, possible confounding variables, including high-community infection rates, were not considered.[1,2,4,6] By investigating Australian parents' perceptions of their children's life-styles before COVID-19 and during Victoria's lockdown, we aimed to explore the effects of restrictions differing in severity and duration on children's health-related behaviours aged 5–17 years. It was hypothesised that Victorian children would experience greater impacts to health-related behaviours (physical activity, sleep, screen time, diet, outdoor activity, family connectedness and social connection) compared to children in NSW and other states and territories, who experienced less severe restrictions.

Methods

Study design

A national-level cross-sectional survey was conducted online from 15th to 29th September 2020 by the Royal Children's Hospital (RCH) National Child Health Poll. The RCH Human Research Ethics Committee approved the study protocol (RCH HREC 35254).

Study sample

Participants were selected in two stages. First, a panel of over 100 000 caregivers were recruited by a private online survey vendor, the Online Research Unit, through online and offline measures creating a panel of Australian caregivers with demographic characteristics representative of the national distribution based on state and territory residency, gender and age. Caregivers were defined as primary carers for at least 1 day per week of a child aged less than 18 years and were required to be 18 years or older, current Australian residents and have internet access. Secondly, a sample of these caregivers (2.5 times the expected sample size of 2000) was randomly selected using age, sex and state stratified random sampling and invited to participate. Caregivers were assumed to provide consent if they voluntarily participated in the survey with a response rate of 81%. One respondent was permitted per household and allocated a unique numerical identifier to ensure anonymity and one-time poll access. For this study, we have included caregivers of children aged 5–17 years.

Measures

The survey questionnaire was developed after extensive review of the scientific and grey literature in liaison with experts on the emerging impacts of the COVID-19 pandemic on families and children.

The survey collected caregivers' gender, age, number of children, family structure, education status, country of birth, state/territory residency, region of residency based on Australian Bureau of Statistics (ABS) Accessibility and Remoteness Index of Australia,[11] Aboriginal and Torres Strait Islander (ATSI) status, and children's age, gender and level of schooling.

Caregivers were asked to report about a typical week from June to September 2020 compared to pre-pandemic (defined as before March 2020). The impact of varying COVID-19 pandemic restrictions, and specifically Victoria's lockdown, on children's life-style was investigated using nine items assessing each child for: (i) time spent physically active, (ii) time spent outdoors, (iii) daily amount of sleep, (iv) difficulty falling/staying asleep, (v) connection to friends, (vi) connection to caregiver, (vii) unhealthy food consumption, (viii) fruit and vegetable consumption and (ix) amount of recreational screen time. Caregivers responded using a 5-point Likert scale (options: a lot less, a little less, about the same, a little more and a lot more), which was converted into a 3-point Likert scale, combining 'a lot less' and 'a little less' as 'less'; 'a lot more' and 'a little more' as 'more' and retaining 'about the same'.

Survey questions required a sixth-grade level of literacy and were administered in English without provision of translators, meaning caregivers who did not speak English were unable to participate.

Data analysis

Demographic characteristics were reported as number (*n*) and percentage (%) separately for Victoria and NSW, while the remaining Australian states and territories were all combined (other states and territories). The impact on children's health-related behaviours was reported as 'more', 'about the same' and 'less' using numbers and weighted proportions.

Changes in children's health-related behaviours were assessed as either 'more' or 'less' compared to 'about the same' in both directions. To assess how the severity of lockdown impacted children's health-related behaviours compared to pre-pandemic, we analysed impacts as either 'more' or 'less' compared to 'about the same' to avoid missing significant changes in behaviour in either direction from children's' baselines. Hence, we compared 'less' against 'about the same' for each of the nine items excluding 'more'. Subsequently, we compared 'more' against 'about the same' excluding 'less'. We used logistic regression to assess changes in children's health-related behaviours between Victoria, NSW and other states and territories during Victoria's lockdown both unadjusting and adjusting for the effect of caregiver demographics (age, gender, family structure, education, income, employment, remoteness and their corresponding child's education, age and gender). A generalised estimating equation was used to account for clustering of children within families. All estimates except for the demographic characteristics (Table 1) were weighted for caregiver's age, gender, number of children in family, state of residence, ATSI status and Socio-Economic Indexes for Areas based on the Index of Relative Socio-Economic Advantage and Disadvantage reflecting the distribution of Australian parent population using figures from the ABS.[12] Data were analysed using IBM SPSS Statistics version 27.[13]

Ethics

Participants were compensated with points to be exchanged for department store gift cards.

Results

Demographics

A total of 1984 caregivers of children aged less than 18 years among 2445 invited caregivers participated in the survey.

Among the total caregivers, 1222 caregivers of children aged 5–17; 386 (31.6%) from Victoria, 387 (31.7%) from NSW, and 449 (36.7%) from other states and territories, were included in this study. Caregivers reported for each of their children, totalling 2011: 617 (30.7%) from Victoria, 636 (31.6%) from NSW and 758 (37.7%) from other states and territories.

Close to half of caregivers were 40–49 years old (49.1%, $n = 666$), female (59.1%, $n = 638$) and 17.0% ($n = 236$) were single parents. Most respondents (81.9%, $n = 1011$) completed at least a high school level of education. Most respondents

Table 1 Demographic characteristics of the caregivers and children surveyed during September 2020 by Victorian, New South Wales, and other states and territories. Characteristics are reported as number (n) and proportions (%)

| Demographic information	VIC, n (%)	NSW, n (%)	Other states and territories, n (%)	Total, n (%)
Caregiver information				
Total	386	387	449	1222
Age group				
18–29 years	11 (2.2)	11 (4.3)	6 (1.4)	28 (2.8)
30–39 years	95 (41.3)	123 (41.5)	126 (35.8)	344 (39.8)
40–49 years	215 (47.2)	207 (45.9)	244 (55.5)	666 (49.1)
>50 years	65 (9.3)	46 (8.2)	73 (7.2)	184 (8.3)
Gender				
Female	200 (55.8)	212 (61.5)	226 (59.5)	638 (59.1)
Family structure				
Single parent	70 (15.1)	77 (20.0)	89 (15.1)	236 (17.0)
Level of education completed				
Year 12 or less	70 (15.9)	62 (20.1)	79 (18.0)	211 (18.1)
Certificate/diploma or trade/apprenticeship	84 (23.3)	112 (30.4)	143 (32.8)	339 (28.8)
Undergraduate or post-graduate	232 (60.7)	213 (49.5)	227 (49.2)	672 (53.1)
Country of birth				
Born in Australia	296 (75.1)	306 (80.6)	329 (70.5)	931 (75.8)
Speaks language other than English at home				
Yes	88 (21.1)	100 (28.0)	72 (12.9)	260 (21.3)
Aboriginal or Torres Strait Islander status				
Aboriginal or Torres Strait Islander	15 (3.9)	18 (4.7)	14 (3.1)	47 (3.9)
Region of caregiver's accommodation				
Metropolitan	339 (83.3)	339 (85.9)	339 (6.0)	1017 (82.2)
Regional	47 (16.7)	48 (14.1)	110 (24.0)	205 (17.8)
Employment status				
Full-time	215 (56.3)	217 (50.0)	240 (54.8)	672 (53.5)
Part-time or casual	91 (19.2)	91 (24.0)	103 (22.7)	285 (22.0)
Unemployed, retired and home duties	80 (24.4)	79 (26.1)	106 (22.5)	265 (24.5)
No. of children				
One child	165 (29.9)	127 (29.5)	163 (26.4)	455 (28.7)
Two or more children	221 (70.1)	260 (70.5)	286 (73.6)	767 (71.3)
Total	617	636	758	2011
Age group				
5 to <13 years	388 (68.7)	437 (71.9)	477 (67.7)	1302 (69.6)
13 to <18 years	229 (31.3)	199 (28.1)	281 (32.3)	709 (30.4)
Gender				
Female	319 (51.3)	316 (51.4)	353 (43.4)	988 (49.0)
Child's school, pre-school or childcare status				
None	12 (1.5)	14 (2.4)	20 (1.7)	46 (1.9)
Childcare	5 (0.6)	18 (2.9)	9 (0.8)	32 (1.5)
Pre-school (kindergarten)	45 (8.2)	72 (15.0)	32 (4.5)	149 (9.6)
School (including Prep, Foundation, Reception, Pre-primary or home schooling)	555 (89.7)	532 (79.6)	697 (93.1)	1784 (87.0)

resided in cities (82.2%, $n = 1017$). Detailed sample demographics are provided in Table 1.

Impact of COVID-19 pandemic restrictions on children's life-styles

Impacts of pandemic restrictions on children's life-style as reported by caregivers are presented in Figure 1.

Physical activity

Most (weighted 57.2%, $n = 352$) Victorian children were reported to be less physically active during the study period, compared to 30.3% (weighted, $n = 183$) of NSW children (adjusted odds ratio (AOR) = 3.7, 95% confidence interval (CI): 2.5–5.5, Table 2) and 26.5% (weighted, $n = 182$) of children from other states and territories (AOR: 5.6, 95% CI: 3.7–8.5). Similarly, most Victorian children were reported to spend less time outdoors during lockdown (weighted 62.6%, $n = 383$), compared to 32.0%
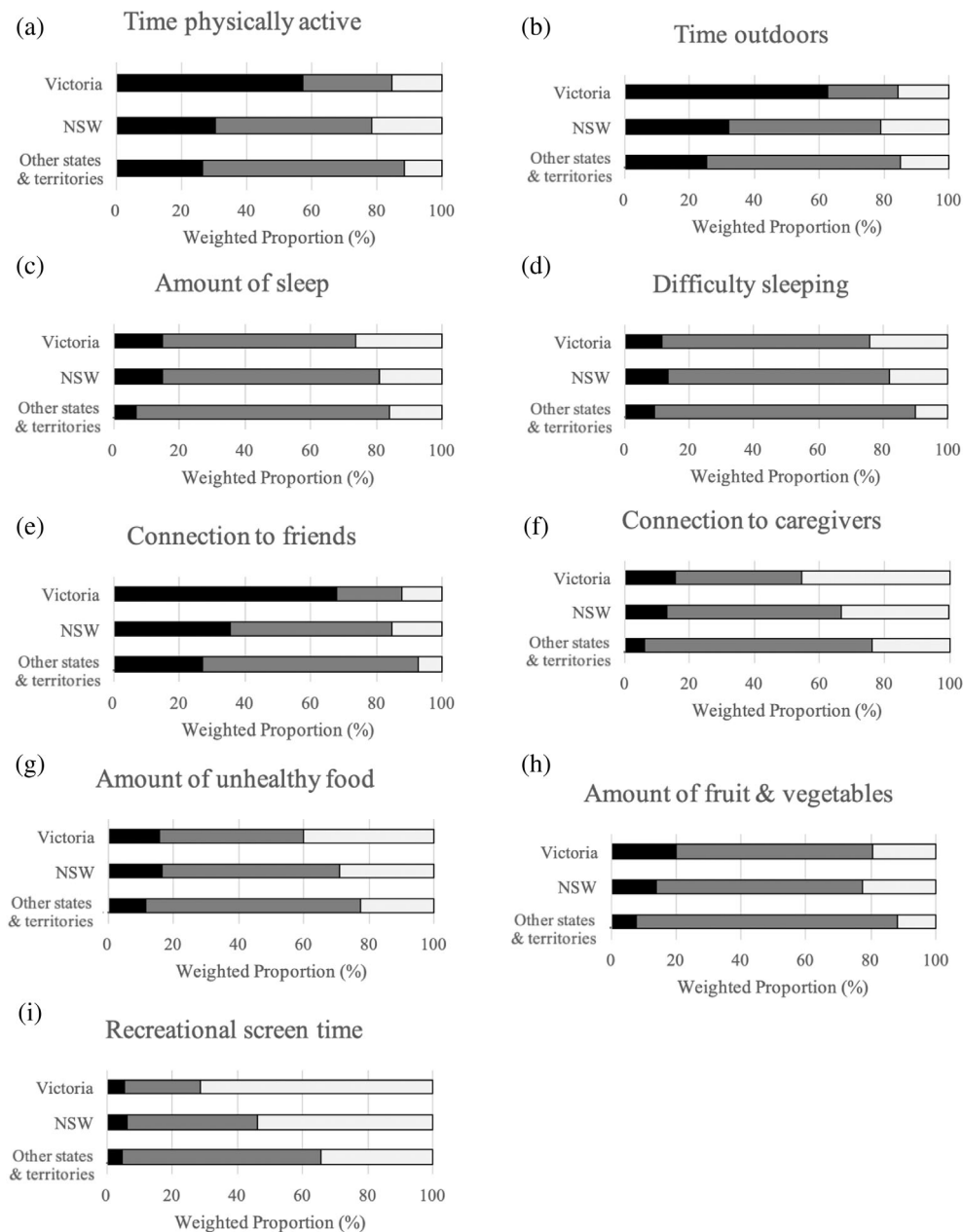
Fig. 1 Impacts of COVID-19 pandemic restrictions and lockdown on children's health-related behaviours in Victoria (804), NSW (807) and other States and Territories (939) surveyed during September 2020. (a) Time spent outdoors, (b) Time physically active, (c) Amount of sleep, (d) Sleep difficulty, (e) Connection to friends, (f) Connection to caregivers, (g) Amount of unhealthy food, (h) Amount of fruit and vegetables, and (i) Recreational screen time. (■) Less, (▩) About the same and (□) More.

Table 2 Parent's perception of changes to health-related behaviour due to COVID in Victoria, New South Wales and other states and territories surveyed during Victoria's lockdown in September 2020. Proportions were reported as 'about the same' against 'less' for each group. Values reported as number (*n*) with proportion (%, weighted†) or odds ratio (OR) with 95% confidence intervals (CIs) and *P* values (unadjusted and adjusted‡) unless otherwise specified

	VIC, n (%, weighted†)	Other states and territories, n (%, weighted†)	VIC compared to other states and territories		VIC, n (%, weighted†)	NSW, n (%, weighted†)	VIC compared to NSW	
			Unadjusted OR† (95% CI; P value)	Adjusted‡ OR† (95% CI; P value)			Unadjusted OR† (95% CI; P value)	Adjusted‡ OR† (95% CI; P value)
Time spent being physically active								
About the same	168 (32.3)	480 (70.1)	1.0	1.0	168 (32.3)	316 (61.5)	1.0	1.0
Less	352 (67.7)	182 (29.9)	4.9 (3.2–7.5; P < 0.001)	5.6 (3.7–8.5; P < 0.001)	352 (67.7)	183 (38.5)	3.4 (2.2–5.0; P < 0.001)	3.7 (2.5–5.5; P < 0.001)
Time spent outdoors								
About the same	132 (25.8)	461 (70.3)	1.0	1.0	132 (25.8)	299 (59.5)	1.0	1.0
Less	383 (74.2)	184 (29.7)	6.8 (4.3–10.7; P < 0.001)	7.0 (4.4–11.1; P < 0.001)	383 (74.2)	198 (40.5)	4.2 (2.7–6.6; P < 0.001)	4.5 (2.9–6.9; P < 0.001)
Amount of sleep per day								
About the same	365 (79.3)	614 (91.8)	1.0	1.0	365 (79.3)	445 (81.3)	1.0	1.0
Less	96 (20.7)	45 (8.2)	2.9 (1.5–5.7; P = 0.001)	3.4 (1.8–6.5; P < 0.001)	96 (20.7)	81 (18.7)	1.1 (0.7–1.9; P = 0.64)	1.4 (0.9–2.4; P = 0.14)
Difficulty falling or staying asleep								
About the same	393 (84.6)	629 (89.4)	1.0	1.0	393 (83.3)	446 (89.4)	1.0	1.0
Less	84 (15.4)	56 (10.6)	1.5 (0.8–2.9; P = 0.118)	1.5 (0.8–2.8; P = 0.23)	84 (15.4)	85 (16.7)	0.9 (0.5–1.5; P = 0.71)	1.0 (0.6–1.6; P = 0.90)
Being connected to friends								
About the same	123 (22.5)	480 (70.5)	1.0	1.0	123 (22.5)	323 (58.2)	1.0	1.0
Less	415 (77.5)	191 (29.5)	8.2 (5.2–12.8; P < 0.001)	9.6 (6.1–15.2; P < 0.001)	415 (77.5)	213 (41.8)	4.8 (3.1–7.4; P < 0.001)	4.9 (3.2–7.6; P < 0.001)
Being connected to caregivers								
About the same	272 (71.5)	536 (91.8)	1.0	1.0	272 (71.5)	356 (80.4)	1.0	1.0
Less	88 (28.5)	44 (8.2)	4.5 (2.1–9.6; P < 0.001)	4.5 (2.0–10.0; P < 0.001)	88 (28.5)	70 (19.6)	1.6 (0.9–3.0; P = 0.11)	1.7 (1.0–2.9; P = 0.075)
Amount of unhealthy food eaten								
About the same	270 (73.5)	502 (85.3)	1.0	1.0	270 (73.5)	352 (76.9)	1.0	1.0
Less	104 (26.5)	66 (14.7)	2.1 (1.1–4.0; P = 0.022)	1.8 (1.0–3.4; P = 0.066)	104 (26.5)	105 (23.1)	1.3 (0.7–2.1; P = 0.52)	1.1 (0.7–2.0; P = 0.64)
Amount of fruit and vegetables eaten								
About the same	382 (75.7)	599 (87.3)	1.0	1.0	382 (75.7)	401 (73.7)	1.0	1.0
Less	133 (24.3)	97 (12.7)	2.2 (1.3–3.7; P = 0.004)	2.1 (1.2–3.7; P = 0.007)	133 (24.3)	160 (26.3)	0.9 (0.6–1.4; P = 0.90)	0.9 (0.6–1.4; P = 0.57)
Amount of time using screens and digital media for entertainment (not school/education)								
About the same	141 (80.4)	427 (92.8)	1.0	1.0	141 (80.4)	260 (86.0)	1.0	1.0
Less	36 (19.6)	26 (7.2)	3.1 (1.2–8.4; P = 0.023)	3.2 (1.1–10.1; P = 0.040)	36 (19.6)	43 (14.0)	1.5 (0.7–3.2; P = 0.29)	1.3 (0.7–2.6; P = 0.45)

† All estimates except for the demographic characteristics were weighted for caregiver's age, gender, number of children, state of residence, ATSI status and Socio-Economic Indexes for Areas based on the Index of Relative Socio-Economic Advantage and Disadvantage reflecting the distribution of Australian parent population using figures from the ABS.[13] ‡ Adjusted for the effect of caregiver demographics (age, gender, family structure, education, income, employment, remoteness and their corresponding child's education, age and gender).

Table 3 Parent's perception of changes to health-related behaviour due to COVID in Victoria, New South Wales and other states and territories surveyed during Victoria's lockdown in September 2020. Proportions were reported as 'about the same' against 'more' for each group. Values reported as number (*n*) with proportion (%, weighted†) or odds ratio (OR) with 95% confidence intervals (CIs) and *P* values (unadjusted and adjusted‡) unless otherwise specified

	VIC, *n* (%, weighted†)	Other states and territories, *n* (%, weighted†)	VIC compared to other states and territories		VIC, *n* (%, weighted†)	NSW, *n* (%, weighted†)	VIC compared to NSW	
			Unadjusted OR† (95% CI; *P* value)	Adjusted‡ OR† (95% CI; *P* value)			Unadjusted OR† (95% CI; *P* value)	Adjusted‡ OR† (95% CI; *P* value)
Time spent being physically active								
About the same	168 (63.6)	480 (84.4)	1.0	1.0	168 (63.6)	316 (69.2)	1.0	1.0
More	97 (36.4)	96 (15.6)	3.1 (1.7–5.5; *P* < 0.001)	3.2 (1.8–5.6; *P* < 0.001)	97 (36.4)	137 (30.8)	1.3 (0.8–2.2; *P* = 0.35)	1.4 (0.8–2.3; *P* = 0.25)
Time spent outdoors								
About the same	132 (58.2)	461 (79.8)	1.0	1.0	132 (58.2)	299 (68.9)	1.0	1.0
More	102 (41.8)	113 (20.2)	2.8 (1.6–5.0; *P* < 0.001)	3.1 (1.7–5.5; *P* < 0.001)	102 (41.8)	139 (31.1)	1.6 (0.9–2.7; *P* = 0.081)	1.7 (1.0–2.8; *P* = 0.061)
Amount of sleep per day								
About the same	365 (68.9)	614 (82.9)	1.0	1.0	365 (68.9)	445 (77.5)	1.0	1.0
More	156 (31.1)	99 (17.1)	2.2 (1.4–3.5; *P* = 0.001)	2.0 (1.2–3.3; *P* = 0.009)	156 (31.1)	110 (22.5)	1.6 (1.0–2.4; *P* = 0.056)	1.6 (1.1–2.6; *P* = 0.029)
Difficulty falling or staying asleep								
About the same	393 (72.7)	629 (88.7)	1.0	1.0	393 (72.7)	446 (79.0)	1.0	1.0
More	140 (27.3)	73 (11.3)	3.0 (1.8–4.9; *P* < 0.001)	3.4 (2.0–5.9; *P* < 0.001)	140 (27.3)	105 (21.0)	1.4 (0.9–2.2; *P* = 0.14)	1.6 (1.0–2.5; *P* = .0035)
Being connected to friends								
About the same	123 (61.9)	480 (89.9)	1.0	1.0	123 (61.9)	323 (76.4)	1.0	1.0
More	79 (38.1)	87 (10.1)	5.5 (2.9–10.2; *P* < 0.001)	5.6 (2.8–11.3; *P* < 0.001)	79 (38.1)	100 (23.6)	2.0 (1.1–3.7; *P* = 0.030)	2.1 (1.1–3.9; *P* = 0.020)
Being connected to caregivers								
About the same	272 (46.4)	536 (74.7)	1.0	1.0	272 (46.4)	356 (61.6)	1.0	1.0
More	257 (53.6)	178 (25.3)	3.4 (2.2–5.2; *P* < 0.001)	3.5 (2.2–5.4; *P* < 0.001)	257 (53.6)	210 (38.4)	1.9 (1.2–2.8; *P* = 0.002)	1.9 (1.3–2.8; *P* = 0.002)
Amount of unhealthy food eaten								
About the same	270 (52.5)	502 (74.5)	1.0	1.0	270 (52.5)	352 (65.5)	1.0	1.0
More	243 (47.5)	190 (25.5)	2.6 (1.7–3.1; *P* < 0.001)	2.8 (1.8–4.3; *P* < 0.001)	243 (47.5)	179 (34.5)	1.7 (1.1–2.6; *P* = 0.009)	1.9 (1.3–2.8; *P* = 0.002)
Amount of fruit and vegetables eaten								
About the same	382 (75.7)	599 (87.3)	1.0	1.0	382 (75.7)	401 (73.7)	1.0	1.0
More	133 (24.3)	97 (12.7)	2.2 (1.3–3.7; *P* = 0.004)	2.1 (1.2–3.7; *P* = 0.007)	133 (24.3)	160 (26.3)	0.9 (0.6–1.4; *P* = 0.62)	0.9 (0.6–1.4; *P* = 0.57)
Amount of time using screens and digital media for entertainment (not school/education)								
About the same	141 (24.5)	427 (63.8)	1.0	1.0	141 (24.5)	260 (42.4)	1.0	1.0
More	440 (75.5)	305 (36.2)	5.4 (3.6–8.3; *P* < 0.001)	5.9 (3.9–8.9; *P* < 0.001)	440 (75.5)	333 (57.6)	2.3 (1.5–3.5; *P* < 0.001)	2.4 (1.6–3.6; *P* < 0.001)

† All estimates except for the demographic characteristics were weighted for caregiver's age, gender, number of children, state of residence, ATSI status and Socio-Economic Indexes for Areas based on the Index of Relative Socio-Economic Advantage and Disadvantage reflecting the distribution of Australian parent population using figures from the ABS. [13] ‡ Adjusted for the effect of caregiver demographics (age, gender, family structure, education, income, employment, remoteness and their corresponding child's education, age and gender).

(weighted, $n = 198$) NSW children (AOR = 4.5, 95% CI: 2.9–6.9) and 25.2% (weighted, $n = 184$) of children in other states and territories (AOR = 7.0, 95% CI: 4.4–11.1). Most Victorian children (weighted 71.3%, $n = 440$) were reported to experience increased recreational screen time during lockdown, compared to 53.9% (weighted, $n = 333$) (AOR = 2.4, 95% CI: 1.6–3.6) of NSW children, and 34.5% (weighted, 305) (AOR = 5.9, 95% CI: 3.9–8.9) of children in other states and territories (Table 3).

Sleep

Victorian children were reported to have slightly increased difficulty sleeping (weighted 24.1%, $n = 140$) compared to NSW (weighted 18.1%, $n = 105$) (AOR = 1.6, 95% CI: 1.0–2.5) and other states and territories (weighted 10.2%, $n = 73$) (AOR = 3.4, 95% CI: 2.0–5.9). Similarly, Victorian children reported to have increased amount of sleep (weighted 26.3%, $n = 156$) was slightly higher than NSW children (weighted 19.1%, $n = 110$) (AOR = 1.6, 95% CI: 1.1–2.6) and other states and territories (weighted 15.9%, $n = 99$) (AOR = 2.0, 95% CI: 1.2–3.3).

Diet

Victorian children were reported to have similar increases in fruit and vegetable intake during lockdown (weighted 19.4%, $n = 133$) as NSW children (weighted 22.7%, $n = 160$) (AOR = 0.9, 95% CI: 0.6–1.4) but higher increase compared to other states and territories (weighted 11.7%, $n = 97$) (AOR = 2.1, 95% CI: 1.2–3.7). Victorian children were reported eating more unhealthy food (weighted 39.9%, $n = 243$) compared to children in both NSW (weighted 28.8%, $n = 179$) (AOR = 1.9, 95% CI: 1.3–2.8) and other states and territories (weighted 22.6%, $n = 190$) (AOR = 2.8, 95% CI: 1.8–4.3).

Connection to peers and caregivers

Most (68% weighted, $n = 415$) Victorian children were reported to feel less connected to their peers during lockdown, compared to 35.4% (weighted, $n = 213$) NSW children (AOR = 4.9, 95% CI: 3.2–7.6) and 27.3% (weighted, $n = 191$) of children from other states and territories (AOR = 9.6, 95% CI: 6.1–15.2). Contrastingly, 45.3% (weighted, $n = 257$) of Victorian children were reported to have increased connection to caregivers, compared to 33.4% (weighted, $n = 210$) of NSW children (AOR = 1.9, 95% CI: 1.3–2.8) and 23.7% (weighted, $n = 178$) of children in other states and territories (AOR = 3.5, 95% CI: 2.2–5.4).

Impact of COVID-19 pandemic restrictions on children's life-styles by age group

The effects of varying levels of pandemic restrictions on health-related behaviours in children were reported to be similar between children aged 5–12 years and 13–17 years except for sleep duration in Victoria and recreational screen time in other states and territories (Fig. S1).

Discussion

This is the first study to investigate the effects of restrictions differing in severity and duration on a broad range of children's health-related behaviours. In contrast to other studies, we compared differing restrictions in Victoria and NSW against other states and territories, which acted as a national control group due to the absence of strict regulations. Our results suggest a dose–response relationship between severity and duration of pandemic restrictions and impacts on children's life-styles. As hypothesised, Victorian children, who experienced more severe restrictions, were more likely to experience greater impacts and predominantly more negative impacts to their health-related behaviours than children in NSW and other states and territories. This is in the context of NSW children who experienced fewer restrictions for a shorter period, and other jurisdictions that did not impose restrictions during the study period.

Our results are consistent with previous studies demonstrating associations between lockdown and increased sedentary behaviours in children largely as a result of increased screen time,[2] decreased physical activity and the disruption to organised sport activities.[1] These findings have implications for the current and future health of affected children, as lockdown-related sedentariness was positively correlated with negative moods[1] and sedentary habits created in childhood often persist into adulthood.[14] Contrasting with German reports of increased physical activity of adolescents' during the pandemic, our findings support Greek and Australian studies suggesting time-based outdoor restrictions are detrimental to children's physical activity levels.[1–4] Pandemic restrictions increased sedentary activity, including screen-based activity across Australia, with effects greatest in Victorian children.[15] Decreased physical activity in other states may be explained by a correlation between fears of catching COVID-19 and behaviour changes.[4] In context, under 20% of Australian teenagers met physical activity or daily screen time guidelines in 2018.[16] Victorian children's further regression from a low pre-COVID baseline is concerning for preventable long-term health conditions.[3,17]

Researchers have hypothesised that children slept longer but with greater disturbance due to changed schedules and increased sedentary activity during lockdowns.[18] While our results support a potential link between sleep duration and lockdown, we did not find a substantial increase in sleep difficulties despite Victorian children's increased sedentary activity.[1,18]

The impact of lockdown on diet has seen polarising effects on children's nutrition world-wide.[3,5,6] Remote learning in French children was linked to increased boredom and stress and greater accessibility to food during school hours, contributing to emotional overeating.[5] This is mirrored in our findings of more unhealthy food behaviours in Victorian children, possibly exacerbated by the established link between increased screen time and unhealthy snacking.[10] However, more flexibility for caregivers working from home may have allowed time for home-cooked meals and increased children's fruit and vegetable intake.[3,9]

Previous research found social isolation due to lockdown increased loneliness in youth.[2,3,7] Our finding of decreased peer connectivity among Victorian children is concerning given prolonged peer-related loneliness predisposes children to depression in adolescence.[19] This may be mitigated through online social interaction to protect mental well-being.[2] Our results support mixed findings on the impact of lockdown on children's relationships with caregivers.[3,7] Forced time together either raised conflicts[7] or created opportunities for positive habits and shared activities.[3]

Little research exists on the longitudinal impacts of pandemic restrictions on health-related behaviours. A study of English adults showed that 29% of participants had persistent reduced physical activity post-lockdown.[20] Children's increase in sedentary behaviour may persist due to poor re-engagement with extracurricular activities due to low motivation and fear,[21] while increased screen usage and less outdoor activity pose risks for early-onset short-sightedness[17] and poorer mental wellbeing.[22] As half of the adults with mental health disorders experience their onset by mid-teens, policies should focus on ways to prevent deterioration of children's health-related behaviours affected by pandemic restrictions in order to improve long-term mental health outcomes.[23]

Some limitations of our study include the possibility of social desirability bias due to underreporting of less desirable behaviours and overestimation of socially acceptable behaviours; however, respondent anonymity may have reduced the potential for this. The study design required parents to respond for their children, future research could address the potential for measurement bias through parent-led behaviour diaries or children self-reporting. In addition, as a retrospective study, there is potential for recall bias. In Victoria, the caregivers may have over reported behaviour changes due to frustrations with ongoing lockdowns. Age-related changes in child behaviour may have occurred over the six-month recall period, irrespective of pandemic restrictions. We have included the age of the child in the statistical model and explored comparison between states to control for the potential age effect. Metropolitan children were not separated from regional children in Victoria, where restrictions were less severe during the survey period. However, children in regional Victoria experienced harsher restrictions than in NSW, where restrictions were consistent state-wide. Eligibility for the COVID vaccine commenced near the end of the survey period for 12–15 year olds, with 5–11 year olds remaining ineligible. Hence, uptake of vaccination in the 12–15 year old age group and subsequently caregivers' decision-making for their children's activity may have a limited influence on the study findings. Furthermore, we did not identify the characteristics of children at risk of multiple adverse health-related behaviours which could be redressed in future studies so that targeted interventional strategies are directed at children needing the most help. Transferability of our findings to the non-English speaking Australian population may also be limited by English literacy requirements and future studies may want to address language inclusivity within survey delivery. Additionally, the effect of cultural backgrounds on parental response to pandemic restrictions is an important area of research for future studies to provide targeted interventional strategies and would be best explored using qualitative methodology.

Conclusions

Our findings show more severe and longer COVID-19 pandemic restrictions, including lockdowns, are associated with greater impacts and predominantly more negative impacts on child health-related behaviours with serious implications for children's current and future physical and mental wellbeing. Considering the ongoing risk of COVID-19 and the emergence of new variants, our findings have significant relevance for the future use of lockdowns and pandemic restrictions in public health policies world-wide. Immediate government action post-pandemic restrictions are required to mitigate the long-term health effects of lockdowns on children through policies and programs to encourage healthier life-style behaviours. Future policies to control pandemics, should allow increased outdoor activity and 'social bubbles' for children to support their physical and mental health.

Data Availability Statement

Individual participant data that underlie the results (text, tables, figures and appendix) reported in this article, after de-identification, will be shared upon request between 9 months and ending 36 months following publication of the article. Requests will be honoured from researchers who provide a methodologically sound proposal and execute a Data Use Agreement with National Child Health Poll. Requests should be directed by email to the corresponding author.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure S1 Impacts of COVID-19 pandemic restrictions and lockdown on children's health-related behaviours in Victoria (617), NSW (636) and other States and Territories (761) surveyed during September 2020 represented as children aged 5 to <13 and 13 to <18 years.