

Non-pharmaceutical interventions and COVID-19 cases in US summer camps: results from an American Camp Association survey

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ABSTRACT

Background Most camps remained closed during Summer 2020, due to concerns regarding child transmission of SARS-CoV-2 and limited information about the effectiveness of non-pharmaceutical interventions (NPIs) within child congregate settings.

Methods We surveyed US camps about on-site operations, camper and staff demographics, COVID-19 cases among campers and staff, and NPI usage as related to pre-camp quarantine, facial coverings, physical distancing, cleaning and facility modifications. For all NPIs, save quarantine, responses were provided on a 5-point Likert scale format.

Results Within 486 on-site camps, a range of NPIs were instituted, most often related to reduced camper interactions, staff face coverings, cleaning and hand hygiene. Camper facial coverings were less common, with campers always wearing masks at ~34% of the camps. Approximately 15% of camps reported 1+ confirmed COVID-19 case in either campers or staff, with three camps reporting a COVID-19 outbreak. In both single and multi-NPI analyses, the risk of COVID-19 cases was lowest when campers always wore facial coverings. Constant use of staff facial coverings and targeted physical distancing measures, but not pre-camp quarantine, also reduced COVID-19 risks.

Conclusions We found constant facial coverings, especially for campers, and targeted physical distancing measures to reduce risks of SARS-CoV-2 transmission within summer camps. Our findings provide valuable insights for future operations of summer camps and other child congregate settings regarding the use of NPIs to reduce the risk of SARS-CoV-2 infection.

anecdotal in nature or based on small sample sizes. This evidence shows that camps that operated during Summer 2020 experienced varying degrees of success in mitigating SARS-CoV-2 transmission, possibly due to differences in the use of NPIs. SARS-CoV-2 transmission, for example, was low within four Maine overnight camps that implemented pre-arrival quarantine, pre-arrival and post-arrival testing and symptom screening, cohorting, face covering use, physical distancing, enhanced hygiene measures, cleaning and disinfecting, and maximal outdoor programming.² In contrast, an overnight camp in Georgia experienced significant SARS-CoV-2 transmission among campers and staff,³ with an overall attack rate of 44%. Attack rates increased with length of time spent at the camp. Transmission was attributed to large number of campers sleeping in the same cabin and frequent singing and cheering without the regular use of facial coverings. Similarly, an outbreak of COVID-19 occurred at a boys' overnight summer school retreat in Wisconsin.⁴ Among 152 attendees, 116 (76%) were classified as having confirmed or probable COVID-19. At this retreat, organisers required documentation of a negative pre-arrival, reverse transcription polymerase chain reaction (RT-PCR) test result, 7-day pre-arrival quarantine and outdoor programming, but did not implement other recommended NPIs.

In this paper, we use data from a nationwide survey of camps operating during Summer 2020 to estimate the prevalence of COVID-19 cases among campers and staff and its relation to individual and multiple NPIs instituted at these camps.

INTRODUCTION

Each year, summer camps in the USA host more than 26 million children and employ 1.5 million staff of all ages, race/ethnicities, genders and socioeconomic position.¹ Alongside the closing of schools, camps were massively disrupted across the USA as a result of the COVID-19 pandemic. Many camp programmes, including approximately 82% of US overnight camps,¹ did not open during Summer 2020, due to a lack of understanding of (1) the degree to which SARS-CoV-2 is transmitted within child congregate settings and (2) the non-pharmaceutical interventions (NPIs) needed to minimise this transmission.

To date, few studies have been conducted that examine SARS-CoV-2 transmission and NPI effectiveness in camp settings, with evidence to date

METHODS

As part of the American Camp Association's (ACA) annual survey of US camps, we asked camps that operated in-person programmes in Summer 2020 to provide information about camper and staff demographics, COVID-19 cases and NPIs via an online questionnaire. This online survey was distributed in September 2020 to ACA-affiliated camps via weekly e-newsletter, direct electronic mail and camp networks. Respondents answered anonymously on behalf of a single camp or multiple camps (if the respondent operated multiple sites). Camps were asked to provide information about (1) their state of operation, (2) the state and countries in which their campers resided, and (3) the number and demographic characteristics (as per cent) of campers and staff, with single-site camps providing



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answers by week and multisite camps as aggregate information over the summer.

In addition, camps were asked to provide data on COVID-19 cases and NPI usage. COVID-19-related questions included those related to the number of confirmed and suspected COVID-19 cases for campers and staff, again reported by week by single-site camps and as aggregate information for each camp by multisite camps. NPI-related questions included those about camp policies with regard to NPI usage and actual NPI usage during camp sessions. These questions specifically asked for information about the frequency of (1) camper and staff quarantine at home or at camp, (2) staff and camper facial coverings, (3) reduced camp capacity, (4) NPIs to promote distancing, such as activity cohorts, physical distancing, decreased visitors, modified programmes, and modified sleeping, dining, and bathroom arrangements, and (5) cleaning measures, including hand sanitising and increased cleaning. For all questions about NPIs, save those about quarantine, the survey asked camps to provide information about the frequency of NPI usage as 'Always', 'Often', 'Sometimes', 'Rarely' or 'Never'.

Camp respondents leaving >50% of overall responses blank were omitted from data analysis. Data were analysed using descriptive statistics, including summary statistics and graphical analysis of camp demographics, as well as NPI usage and reported COVID-19 cases and outbreaks among campers and staff overall and across time. NPI effectiveness was examined using risk ratios, which were calculated as the ratio of COVID-19 cases per number of campers attending camps always using the NPI of interest divided by the ratio for camps not always using the NPI. Risk ratios for multiple NPIs were calculated as the ratio of COVID-19 cases per number of campers attending camps that always used both NPIs of interest versus those that did not. Pairs of NPIs for this analysis were selected from those NPIs that (1) were found to be highly effective at reducing COVID-19 cases when examined individually and (2) were used together with sufficient frequency to allow for their combined analysis. Since the number of camps providing information about individual

NPIs varied slightly, we also calculated risk ratios for the individual NPIs of interest using data subsets corresponding to the multiple NPI analysis to allow appropriate comparisons to be made. All analyses were performed using R statistical software (R V.4.0.3).

RESULTS

A total of 1193 single and multisite camps completed the survey, representing 1489 camps, as shown in [table 1](#). Camps were located in 49 states and the District of Columbia, with 26% located in the Midwest, 23% in the Northeast, 22% in the South and 16% in the West. The racial and socioeconomic distribution of campers mirrored that of the entire camp population.¹ Approximately 73% of campers identified as white, 8.3% black, 6.0% Hispanic, 4.2% Asian, and 6.0% biracial or multiracial, while about 48% of campers were from middle-income, 34% from high-income and 18.5% from low-income households.

Four hundred eighty-six of the responding camps, serving about 90 000 campers, operated on-site during Summer 2020, including 59 overnight, 206 day, and 220 combination day, overnight, and rental camps (with one missing response). As shown in [figure 1](#), day and overnight single-site camps operated in all regions of the USA, with lower rates of operation in the West and highest rates of operation in the Northeast. Rates of operation for the single-site camps were highest during the middle of the summer in all regions of the USA, as shown by the mid-summer peak in the number of camps, children and staff at these single-site camps ([figure 1](#)).

NPI usage

NPI usage for all on-site camps is shown in [table 2](#). Most camps reported always using NPIs related to staff facial coverings (69%), reduced capacity (89%), smaller cohort sizes (86%), increased cleaning (95%) and more frequent handwashing (96%). Constant physical distancing (66%) and face coverings among campers (33%) were reported by a smaller number of camps. Correspondingly, approximately one-third of camps required campers and staff to quarantine at home prior to

Table 1 Summary of the number of camps, campers and confirmed COVID-19 cases: Summer 2020

Camp descriptor	Number*		Confirmed cases†			Total
	Camps	Children	Camps	Camper	Staff	
Operations for Summer 2020						
All surveyed camps	1489	89 805	74	30	72	102
On-site	486	89 635	74	30	72	102
Camp type (on-site only)						
Overnight	59	16 228	10	11	30	41
Day	206	25 826	52	16	29	45
Combination	220	47 581	12	3	13	16
Missing	1	0	0	0	0	0
Camp type (on-site only)						
Single camp	295	70 982	36	27	65	92
Multisite camp	191	18 653	38	3	7	10
Region (on-site only)						
Midwest	124	17 259	34	10	30	40
Northeast	113	24 665	8	5	12	17
South	108	20 605	15	9	18	27
West	78	11 696	10	1	7	8
Missing	63	15 410	5	5	5	10

*Number of camps that responded to the survey; number of children on-site for Summer 2020 estimated as unique campers.

†Number of camps that reported cases; number of confirmed camper and staff cases.

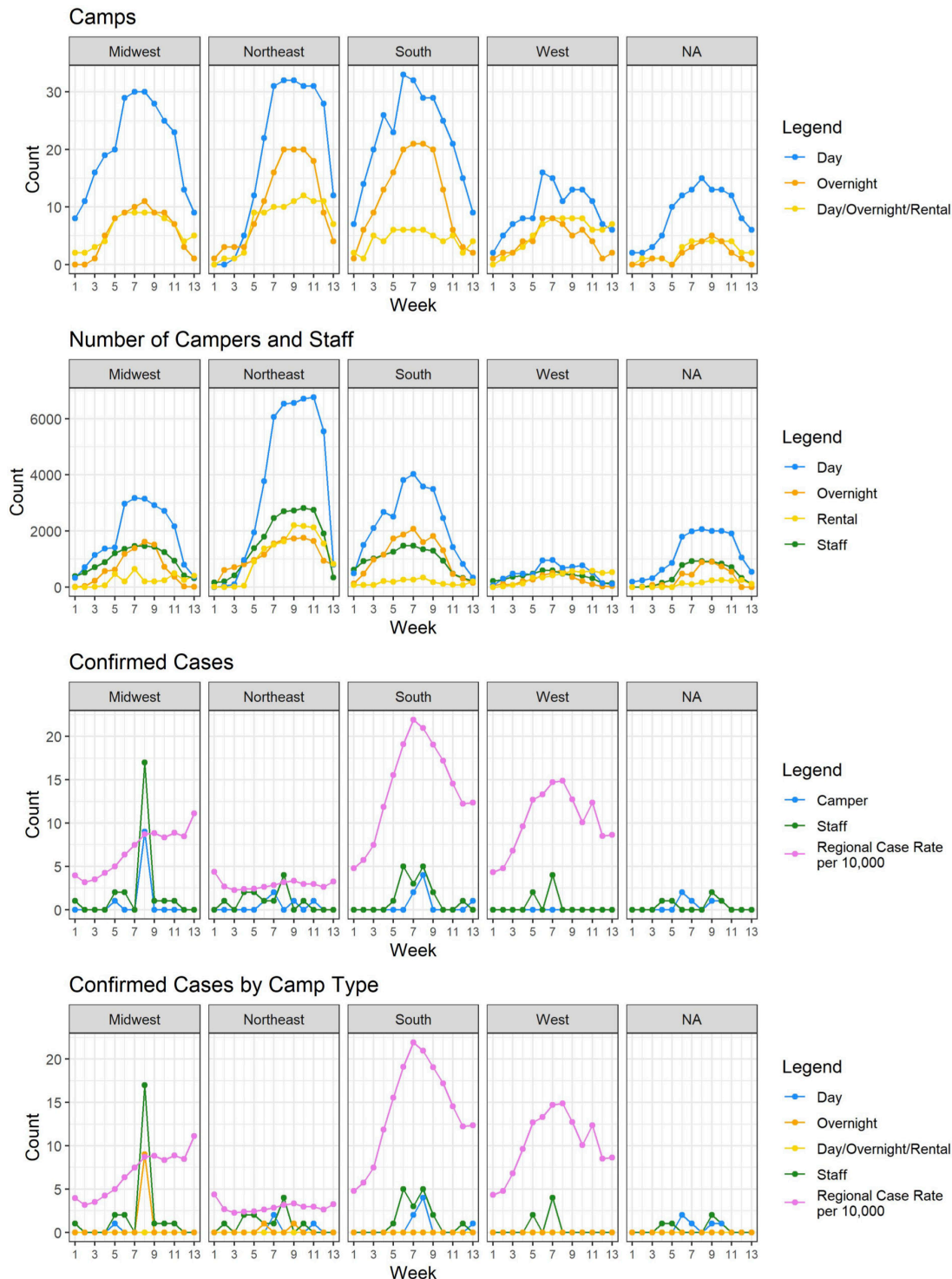


Figure 1 Weekly number of single-site camps and associated campers, staff, and cases: by camp type, region. "NA" represents "non-available", including camps that did not provide relevant data.

attending camp, with fewer camps requiring staff to quarantine at camp and only 18 requiring campers to quarantine at camp. Modifications to sleeping arrangements were fairly typical among overnight and combination overnight/day/rental camps, while altered dining and bathroom arrangements were more common at day and combination camps.

COVID-19 cases and outbreaks

As shown in [table 1](#), on-site camps reported 30 and 72 confirmed COVID-19 cases and 81 and 119 suspected cases for campers

and staff, respectively. A total of 74 camps reported having at least one confirmed COVID-19 case and 127 camps reported having at least one confirmed or suspected COVID-19 case. Of the camps with a confirmed case, 10 camps were overnight, 52 were day and 12 were combination overnight/day/rental camps.

For single-site camps, which reported data on COVID-19 cases by week, the number of confirmed COVID-19 cases each week was generally low ([figure 1](#)). Cases occurred primarily in mid-summer, corresponding to weekly trends in the number of

Table 2 NPI usage and camper and staff number and COVID-19 cases

NPI	Total number*		No with/of confirmed cases			Risk ratio (95% CI)†		
	Camps	Campers‡	Camps	Campers	Staff	Campers	Staff	
Pre-camp quarantine at home								
Campers	Yes	97	26 311	17	16	40	2.82 (1.36, 5.86)**	2.86 (1.80, 4.55)***
	No	285	60 254	54	13	32		
	Missing	104						
Staff	Yes	103	25 701	16	16	39	3.07 (1.45, 6.49)**	2.81 (1.76, 4.48)***
	No	278	59 196	53	12	32		
	Missing	105						
Pre-camp quarantine at camp								
Campers	Yes	18	7580	7	0	7	0.00 (0.00, -)	1.07 (0.49, 2.34)
	No	337	72 038	59	27	62		
	Missing	131						
Staff	Yes	73	25 151	10	9	26	1.18 (0.53, 2.62)	1.39 (0.86, 2.26)
	No	293	59 225	57	18	44		
	Missing	120						
Facial coverings								
Campers	Always	126	30 883	13	5	6	0.36 (0.14, 0.95)**	0.17 (0.08, 0.40)***
	Not always	255	56 176	59	25	63		
	Missing	105						
Staff	Always	268	60 682	56	14	33	0.39 (0.19, 0.80)**	0.38 (0.24, 0.60)***
	Not always	122	27 117	18	16	38		
	Missing	96						
Decreased capacity								
	Always	326	56 838	63	24	63	1.44 (0.59, 3.52)	3.77 (1.63, 8.72)***
	Not always	39	20 429	9	6	6		
	Missing	121						
Physical distancing								
	Always	257	57 183	56	11	40	0.31 (0.15, 0.65)**	0.67 (0.42, 1.07)
	Not always	133	30 616	18	19	32		
	Missing	96						
Use of cohorts, pods, bubbles								
	Always	301	63 501	65	18	48	0.39 (0.19, 0.82)**	0.63 (0.37, 1.06)
	Not always	49	16 653	6	12	20		
	Missing	136						
Modified programmes to allow for physical distancing								
	Always	292	61 289	59	13	59	0.30 (0.15, 0.61)**	0.52 (0.32, 0.82)***
	Not always	91	23 895	15	17	31		
	Missing	103						
Decreased visitors, including parents								
	Always	308	70 896	70	27	68	1.39 (0.42, 4.57)	2.62 (0.96, 7.18)
	Sometimes	47	10 922	4	3	4		
	Missing	131						
Increased cleaning frequency								
	Always	371	80 997	69	27	69	0.71 (0.21, 2.33)	2.71 (0.66, 11.03)
	Not always	18	6352	4	3	2		
	Missing	97						
Regular hand hygiene								
	Always	374	81 247	71	27	71	0.72 (0.22, 2.37)	5.68 (0.79, 40.87)

Continued

Table 2 Continued

NPI	Total number*		No with/of confirmed cases			Risk ratio (95% CI)†	
	Camps	Campers‡	Camps	Campers	Staff	Campers	Staff
Not always	15	6499	3	3	1		
Missing	97						
Altered dining to decrease numbers or increase physical distancing							
Always	257	65 365	60	23	60	0.24 (0.09, 0.63)**	1.57 (0.38, 6.40)
Not always	24	3411	4	5	2		
Missing	205						
Changed or increased bathroom facilities							
Always	160	39 463	31	7	31	0.34 (0.15, 0.80)**	0.90 (0.56, 1.47)
Not always	139	40 301	19	21	35		
Missing	187						

p<0.05; *p<0.001

*Does not include camps that did not report data for examined NPI.

†Risk ratio for always versus not always. Risk ratios for staffers determined using number of campers as denominator.

‡Number of campers estimated from unique number of on-site campers.

NPI, non-pharmaceutical intervention.

campers and staff and the overall US case rates. Five camps experienced more than five total cases among campers and staff, of which three experienced a COVID-19 outbreak (>3 cases in a week). In the largest of these outbreaks, camp A experienced 26 confirmed cases (9 campers, 17 staff) out of 66 overnight campers and 20 staff in 1 week. The NPIs instituted at camp A were limited to regular hand sanitising, increased cleaning, and pre-camp quarantining at home for campers and at home and camp for staff. The other two outbreaks occurred in day camps that used a wider range of NPIs. In camp B, among a group of approximately 100 day campers and 30 staff, 4 confirmed cases in campers and 3 in staff during a 1-week period were reported. This camp reported always requiring quarantining before camp, staff facial coverings, increasing cleaning, regular hand hygiene, and instituting measures to decrease its capacity and visitor access. Further, camp B reported always or often instituting measures to increase physical distancing, through, for example, use of cohorts or pods or modified programme, dining and bathroom arrangements. However, camper facial coverings were not typical at camp B. In the second day camp, camp C, which had 199 day campers and 82 staff, 4 confirmed and 9 suspected cases among staff were experienced during 1 week. At this camp, camper and staff facial coverings, physical distancing, cleaning, decreased visitors and decreased capacity, but not quarantine measures, were always or often in place.

COVID-19 case rates

Case rates were higher among campers in day as compared with overnight camps and camps with multiple programme types, but the opposite pattern was observed for staff, with case rates for staff higher in overnight as compared with other camps. The incidence rates for COVID-19 cases among campers and staff were 3.3 and 8.03 per 10 000 campers, respectively. Incidence rates were statistically similar among campers in overnight and day camps of 6.78 and 6.20, respectively (RR: 1.09, 95% CI: 0.51 to 2.35). For staff, RRs comparing overnight with day camps were also statistically insignificant at the 0.05 level, although the RR was larger than 1 (1.65, 95% CI: 0.99 to 2.75) reflecting the outbreak in staff at one overnight camp. Across all on-site camps, risks of COVID-19 cases for campers and staff together were similar irrespective of whether the campers travelled from out of

state to attend camp, with a statistically insignificant RR of 0.92 (95% CI: 0.61 to 1.41).

Impact of NPI usage on COVID-19 case rates

The risk of COVID-19 cases was significantly reduced when campers or staff always wore facial coverings (table 2). COVID-19 risks for campers were 0.36 (95% CI: 0.14 to 0.95) and 0.39 (95% CI: 0.08 to 0.40) times as high in camps with strict face covering policies for campers and staff, respectively, as compared with camps without, indicating that campers attending camps where face coverings were always worn had an approximately two-thirds reduction in risk of COVID-19 as compared with other campers. Correspondingly, COVID-19 risks were also reduced for staff working in camps where campers or staff always wore face coverings as compared with where they did not, with an 83% (RR: 0.17, 95% CI: 0.08 to 0.40) and 62% (RR: 0.38, 95% CI: 0.24 to 0.60) reduction in risks, respectively.

Pre-camp home quarantine measures for campers or staff were not found to significantly reduce risk of COVID-19 cases for either group. While no confirmed COVID-19 cases were experienced in camps requiring campers to quarantine at camp, the number of camps with such requirements was low. Targeted physical distancing measures, including use of cohorts, physical distancing and modified programmes to allow for physical distancing, were associated with less risk of COVID-19 cases in campers and to a lesser extent in staff. When evaluated individually, each of these physical distancing measures when always used produced similar reductions in risk, with rate reductions in campers of 61% (RR: 0.39, 95% CI: 0.19 to 0.82) for cohorts, 69% (RR: 31, 95% CI 0.15 to 0.65) for physical distancing measures and 70% (RR: 0.30; 95% CI: 0.15 to 0.61) for programmes modified to increase physical distance. While statistically significant, risk reduction for staff was less pronounced when programmes were modified for physical distancing, with approximately 50% (RR: 0.52, 95% CI: 0.32 to 0.82) reduction in COVID-19 risk as compared with staff working at other camps. While RRs were below 1, risks did not differ significantly for staff working at camps where cohorts or physical distancing NPIs were always as compared with not always in place. Risks for campers and staff were not reduced in camps that always decreased its capacity (campers: 1.44, 95% CI: 0.59 to 3.52); staff: 3.77, 95% CI: 1.63 to 8.72).

Table 3 Effect of multiple NPI combinations on total (camper and staff) COVID-19 cases*

NPI	Response	Number		Number of cases			RR (95% CI)	
		Camps	Campers	Camps	Campers	Staff	Campers	Staff
Camper and staff facial covering	Neither	118	26 589	18	16	39		
	Camper facial covering only	0	0	0	0	0	–	–
	Staff facial covering only	137	29 587	41	9	24	0.51 (0.22 to 1.14)	0.55 (0.33 to 0.92)
	Both	126	30 883	13	5	6	0.27 (0.10 to 0.73)	0.13 (0.06 to 0.31)
Camper facial covering and home camper quarantine	Neither	195	42 087	47	11	29		
	Camper facial covering only	87	17 547	6	2	2	0.44 (0.10 to 1.97)	0.17 (0.04 to 0.69)
	Home camper quarantine only	56	14 029	12	14	34	3.82 (1.73 to 8.41)	3.52 (2.14 to 5.77)
	Both	34	10 786	4	2	4	0.71 (0.16 to 3.20)	0.54 (0.19 to 1.53)
Camper facial covering and physical distancing	Neither	110	25 477	17	18	32		
	Camper facial covering only	21	5019	1	1	0	0.28 (0.04 to 2.11)	0.00 (0.00 to NA)
	Physical distancing only	145	30 699	42	7	31	0.32 (0.13 to 0.77)	0.80 (0.49 to 1.32)
	Both	105	25 864	12	4	6	0.22 (0.07 to 0.65)	0.18 (0.08 to 0.44)
Camper facial coverings and modified programmes	Neither	85	23 113	15	17	31		
	Camper facial coverings only	4	662	0	0	0	0.00 (0.00 to NA)	0.00 (0.00 to NA)
	Modified programmes only	167	31 384	44	8	32	0.35 (0.15 to 0.80)	0.76 (0.46 to 1.25)
	Both	120	29 285	13	5	6	0.23 (0.09 to 0.63)	0.15 (0.06 to 0.37)
Physical distancing and modified programmes	Neither	79	19 504	14	17	30		
	Physical distancing only	12	4391	1	0	1	0.00 (0.00 to NA)	0.15 (0.02 to 1.09)
	Modified programmes only	54	11 112	4	2	2	0.21 (0.05 to 0.89)	0.12 (0.03 to 0.49)
	Both	238	50 177	55	11	39	0.25 (0.12 to 0.54)	0.51 (0.31 to 0.81)
Physical distancing and home camper quarantine	Neither	99	21 689	10	4	8		
	Physical distancing only	186	38 565	44	9	24	1.27 (0.39 to 4.11)	1.69 (0.76 to 3.75)
	Home camper quarantine only	32	8807	8	15	24	9.24 (3.07 to 27.82)	7.39 (3.32 to 16.44)
	Both	61	16 008	9	1	16	0.34 (0.04 to 3.03)	2.71 (1.16 to 6.33)
Modified programmes and home camper quarantine	Neither	70	16 915	10	3	9		
	Modified programmes only	212	40 724	44	10	23	1.38 (0.38 to 5.03)	1.06 (0.49 to 2.29)
	Home camper quarantine only	19	6860	5	14	22	11.51 (3.31 to 40.03)	6.03 (2.78 to 13.08)
	Both	72	17 955	12	2	18	0.63 (0.10 to 3.76)	1.88 (0.85 to 4.19)

*Comparisons made using subset of data for which there are complete data for each examined NPI. RRs calculated comparing one or two NPIs to neither NPI. NPI, non-pharmaceutical intervention; RR, relative risk.

Since NPIs are often implemented together, we also examined RRs for specific pairwise NPI combinations (table 3). As with individual NPIs, we found that constant camper facial coverings consistently lowered risks for campers and staff, regardless of what other NPI was also used. RRs were lowest in camps that always had both campers and staff wear facial coverings, with a 73% (RR: 0.27; 95% CI: 0.10 to 0.73) and 87% (RR: 0.13; 95% CI: 0.06 to 0.31) reduction in risks, respectively, as compared with camps where neither campers nor staff always wore facial coverings. This reduction in risks was greater than that when only staff, but not campers, wore facial coverings.

We found an approximate 80% reduction in risks for both campers (RR: 0.22; 95% CI: 0.07 to 0.65) and staff (RR: 0.18; 95% CI: 0.08 to 0.44), when camps always implemented both camper facial coverings and a physical distancing NPI, as compared

with when neither was always implemented. This reduction in risks was larger than that when only physical distancing NPIs were always implemented. When two targeted physical distancing NPIs—physical distancing and modified programmes to increase physical distancing—were always implemented together, RRs were significantly lower as compared with camps where neither was always implemented. However, risks for camps implementing both physical distancing NPIs were similar to camps implementing just one physical distancing NPI. The additional use of pre-camp home quarantine did not reduce risks beyond that afforded by physical distancing or facial coverings alone.

DISCUSSION

In our sample of 486 camps operating during Summer 2020, we found lower risks of COVID-19 cases associated with constant use of facial

coverings and physical distancing measures. Our study demonstrated COVID-19 incidence rates for campers and staff of 3.35 and 8.03 per 10 000 campers, resulting in a total of 30 and 72 confirmed cases, respectively. COVID-19 case rates in summer camps were lower than that reported in the USA during the same period, which on 1 June 2020 were estimated to equal approximately 55 cases per 10 000 people, increasing to 184 cases per 10 000 people by 31 August.⁵ COVID-19 case rates in overnight and day camps were statistically similar. A range of NPIs were instituted at the surveyed camps, with RRs for both individual and multiple NPIs consistently demonstrating lower COVID-19 case rates in camps always using facial coverings, particularly by campers, and of targeted physical distancing measures, such as use of cohorts or programme modifications to increase physical distancing.

Decreased camper capacity was not associated with COVID-19 risk reduction. Given the importance of targeted physical distancing measures, our null finding suggests that camper density is less important to COVID-19 risk than physical distancing. Similarly, pre-camp quarantining was also not associated with decreased COVID-19 risks in our study, contrary to its effectiveness in other studies, including that of four Maine overnight camps which attributed its low COVID-19 cases in part to implementation of strict pre-arrival quarantine, which allowed for subsequent isolation and contact quarantining, preventing further SARS-CoV-2 transmission within camps.² Our divergent findings may be attributed to the small numbers of camps in the Maine study and to the relatively few number of camps that used pre-camp quarantine measures in our study.

Our findings are consistent with earlier reports of (1) lower COVID-19 incidence rates in children overall⁶ and within congregate settings⁷, (2) reduced risks of COVID-19 cases associated with the use of facial coverings and physical distancing,^{2,8-10} and (3) reports of COVID-19 cases in camps where use of facial coverings was not universal.^{3,4,11} For example, in a study of COVID-19 cases and transmission in 17 Wisconsin schools, authors reported low transmission rates in schools that required student masking and cohorting.¹⁰ Correspondingly, a study of almost 2 million confirmed COVID-19 cases from 190 countries¹² examined the individual and combined effectiveness of mandatory public face coverings, quarantine, social distancing, and traffic restrictions on the COVID-19 effective reproduction number (R_e) and found physical distancing measures and the simultaneous implementation of 2+ NPIs to provide the greatest reductions in R_e . This study also found individual implementation of any of the examined NPIs, including mandatory facial coverings, to reduce R_e of COVID-19. Our study results were largely consistent with these findings, although we found camper facial coverings (and not physical distancing measures) to be the NPI most important to COVID-19 risk reduction in campers and to a lesser degree in staff. The importance of camper facial coverings in our study likely reflects the fact that in summer camps (and other child congregate settings), children spend considerable time each day in close proximity when SARS-CoV-2 transmission may occur.

Our study has several limitations. First, our findings are based on aggregate data reported by camps, and as such, measures of NPI usage and COVID-19 cases were not independently verified. As a result, COVID-19 cases were likely underestimated due to under-reporting and lack of detection of asymptomatic cases. It is also possible that NPI usage was underestimated or overestimated. Second, our findings may be affected by selection bias, resulting from the self-selection of camps voluntarily participating in our survey. Demographics of camps participating in the survey mirrored that of the overall camp population, suggesting that selection bias was minimal. Third, completion rates of several survey questions were below 75%, suggesting the potential for reporting bias in regard to what information they chose to report.

Our study represents the largest review of day and overnight camps in the USA, documenting COVID-19 cases and the usage and adherence to numerous NPIs. These data allowed us to characterise COVID-19 risks to both campers and staff and to assess the impact of NPIs. In so doing, we provided important, additional evidence of the importance of strict facial covering and targeted physical distancing measures to reduce the risk of SARS-CoV-2 infection in campers and staff.

What is already known on this subject

- ▶ Approximately 82% of US overnight camps did not open during Summer 2020 due to concerns regarding children's ability to transmit SARS-CoV-2. Camps that did operate during this time instituted varied non-pharmaceutical interventions (NPIs) to reduce SARS-CoV-2 transmission, with little information available on the effectiveness of these NPIs within child congregate settings. Large population-based studies are needed to improve our understanding of the extent of SARS-CoV-2 infection among children and their caregivers and to determine whether and to what degree child congregate programmes can safely open during the pandemic.

What this study adds

- ▶ Our study, the largest survey of COVID-19 cases in child congregate settings at the national level, provides new information on the relative effectiveness of NPIs on mitigating COVID-19 cases among children and staff within US camp settings. The observed rates of documented COVID-19 cases among campers were low relative to the case rates reported for corresponding communities in the USA. We found constant camper facial coverings to be the most effective risk reduction method for SARS-CoV-2 transmission within camps. While less effective, constant use of staff facial coverings and targeted physical distancing measures, but not pre-camp quarantine, were also shown to reduce COVID-19 risks. Our findings help to reduce risks of SARS-CoV-2 spread among campers, helping to guide the successful opening and operation of camps within the USA.

Contributors HS conceptualised and designed the study, designed the data collection instrument, drafted, reviewed and revised the manuscript. JM conducted data analyses and reviewed the manuscript. LB reviewed the manuscript. LBR designed the data collection instruments, collected data and reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Competing interests LBR is the director of research at the American Camp Association and together with HS, designed the survey instrument. ACA subsequently collected the data and provided them to HS for analysis, but did not engage in data analysis. LBR also reviewed the manuscript. LB is the medical director to summer camp. The other authors have no conflicts of interest relevant to this article to disclose.

Patient consent for publication Not required.

Ethics approval The study was approved by the Institutional Review Board at Tufts University.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Requests for the data should be made to the American Camp Association.

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