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Factors influencing individual ability to follow physical distancing recommendations in Aotearoa New Zealand during the COVID-19 pandemic: a population survey

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ABSTRACT

Physical distancing (also commonly known as social distancing) is an important non-pharmaceutical strategy to minimise the risk of transmission of SARS-CoV-2 virus. A range of restrictions to promote physical distancing form a key part of the Aotearoa New Zealand (NZ) all-of-government response to the global COVID-19 pandemic. The effectiveness of physical distancing strategies is highly dependent on buy-in and the actions of individuals, households and communities. This NZ population survey was conducted to identify people's views on the effectiveness of various strategies, and factors impacting on their capacity to follow physical distancing requirements during Alert Levels 4, 3, and 2 (April 24th–June 8th 2020). The majority of the 2407 participants were supportive of the public health measures implemented to promote physical distancing across Alert Levels. Few substantial differences were observed in relation to demographic characteristics, suggesting high overall levels of understanding and willingness to adhere to distancing requirements. Around half of the participants reported difficulties practicing physical distancing when in public. Reasons included being an essential worker and challenges related to the behaviour of others. These survey findings highlight the willingness of NZ's population to play their part in eliminating COVID-19 transmission, and the way in which behavioural change was rapidly adopted in line with government requirements.

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Introduction

Aotearoa New Zealand's (NZ) all-of-government public health response to the global SARS-CoV-2 novel coronavirus (COVID-19) pandemic included the establishment of a four-tiered system of Alert Levels in March 2020. These served as a way to define the level of risk posed by COVID-19 in the community, with each Alert Level outlining a range of measures and restrictions designed to manage and minimise the spread of infection (New Zealand Government 2020). The nationwide move to Alert Level 4 on 25 March 2020 placed the country into a 'lockdown' that lasted for just over four weeks. Strict border and travel restrictions were imposed; everyone except essential workers was required to stay at home; non-essential workplaces, schools, libraries, museums, cinemas and hospitality venues (bars, restaurants) were closed; and social gatherings, celebrations, funerals and tangihanga were banned. A shift to Alert Level 3 on 28 April (duration two weeks) primarily allowed more businesses to resume trading on the proviso that the safety of workers and customers was maintained through physical distancing. A move was made to Alert Level 2 on 15 May, and Alert Level 1 commenced on 9 June 2020.

Physical distancing to reduce the spread of infection

Individual and population-level physical distancing are critical non-pharmaceutical public health measures that can mitigate the spread of infection during a pandemic (Flaxman et al. 2020). SARS-CoV-2, the virus that causes COVID-19, spreads primarily via person-to-person contact. When droplets from the mouth or nose of an infected person (including those who are pre-symptomatic) are released into the air through talking, laughing, singing, sneezing or coughing, those droplets can then land in the mouths or noses of nearby people (Centers for Disease Control and Prevention 2020). Transmission occurs more readily when people are in close contact with each other for a prolonged period (World Health Organization 2020b). This was evident in the findings from a study in China that analysed 75,465 COVID-19 cases and found 78%–85% of clusters occurred within household settings (World Health Organization 2020c).

Physical distancing has been a vital part of the COVID-19 pandemic response in NZ. The concept of the 'bubble' (describing a household grouping or the people we are living with) was introduced early in the response as a way of easily communicating the importance of remaining distant from others (New Zealand Herald 2020) to limit exposure to, and transmission of, COVID-19. A similar concept, the 'support bubble' was adopted in the United Kingdom (Long 2020), to remind people to limit close contact to people within the same household. Catchphrases like 'Stay in your bubble' and 'Don't break your bubble' were embraced by people of all ages and became an important part of public health messaging (Wiles 2020a, 2020b). Many New Zealanders began working and learning from home as movement outside of households for non-essential workers was permitted only to access essential services or to exercise locally whilst maintaining a 2-m distance from others (New Zealand Government 2020). Only those employed in essential services (such as healthcare, supermarkets, primary industries, transport, and emergency services), were permitted to leave their households for work.

Predictors of behavioural change

The effectiveness of physical distancing as a strategy to reduce the spread of infection is highly dependent on community buy-in and widespread uptake by individuals, households and communities (Maharaj and Kleczkowski 2012; Hashmi et al. 2016). When NZ moved to Alert Level 3 and then to Level 4 a mere 48 h later, little was known about whether people would be willing or able to adhere to 'stay at home' orders and physical distancing requirements, or what unintended consequences might hamper and impact people's ability to follow advice and guidance (Rubin et al. 2009; Kavanagh et al. 2012; Brooks et al. 2020). It is clear that intention to follow advice does not always translate into action (Tooher et al. 2013). A range of factors are known to explain and predict compliance and behavioural change in the context of infectious diseases, including knowledge of measures and self-efficacy in following them, trust in the authorities that enact them, and perceptions of disease severity, susceptibility to disease, and economic and psychological benefits and costs (Janz and Becker 1984; Verelst et al. 2016; Briscese et al. 2020; Chong et al. 2020). For example, research into the 2009 influenza A (H1N1) pandemic showed that not only did people's perceptions about the severity of an outbreak and their perceived risk of infection predict behavioural change, but so too did their trust in authorities and the quality of information provided to them during that pandemic (Rubin et al. 2009; Tooher et al. 2013). Qualitative research undertaken in NZ to inform the development and delivery of health messages related to H1N1 and subsequent public health campaigns found that participants wanted clear messages about specific actions that can be taken to protect themselves and their families, and for transparent and honest communication to convey both good and bad news alongside specific details about symptoms, infection and death rates (Gray et al. 2011).

Social and cultural determinants, economic disadvantage, and health inequities also impact on people's ability to change behaviour in response to public health advice in a pandemic (Abrams and Szefler 2020; Van Bavel et al. 2020). Measures imposed to promote physical distancing, including stay at home orders or lockdowns, can have a significant negative impact on individuals, families and communities as social and many economic activities grind to a halt (World Health Organization 2020a). For example, focus groups conducted in NZ following the 2009 H1N1 pandemic identified a willingness of participants to physically distance and stay home if they were sick (Gray et al. 2012), but with an acknowledgement that economic pressures to go to work would likely drive their actual behaviour more than their belief in isolation as an important public health measure (Gray et al. 2012). Being able to physically distance has been described as 'a privilege that is simply not attainable by some communities' (Yancy 2020), particularly those more impacted by adverse social determinants of health (Abrams and Szefler 2020).

Heightened risk of COVID-19 severity and mortality among indigenous and ethnic minority communities in the United States, Brazil, Australia and the United Kingdom have highlighted existing health and socioeconomic inequities (Haworth-Brockman and Betker 2020; Shadmi et al. 2020; Yashadhana et al. 2020). During the lockdown, people living in overcrowded households or unhealthy housing will likely face more challenges than those who are not disadvantaged in this way (Abrams and Szefler 2020). Indigenous, ethnic minority and migrant populations are among those more likely to live in

crowded conditions, face language and cultural barriers that limit access to information and advice about mitigating strategies, and have more limited access to healthcare services for testing and medical care (Shadmi et al. 2020). NZ has a well-documented history of social and economic inequities that impact on health outcomes (Ministry of Health 2002; Health Quality & Safety Commission 2019). For Māori, inequity is seen across the life course, in access to services, in the quality of services received and in both morbidity and mortality (Health Quality & Safety Commission 2019). Māori experience far greater rates of household crowding and unhealthy housing than Pākehā (non-Māori New Zealanders) (Ministry of Health 2014). Māori also experience an inequitable burden of non-communicable diseases (Health Quality & Safety Commission 2019) – including those likely to place individuals at increased risk of complications from COVID-19 such as chronic respiratory disease, asthma, hypertension, diabetes, cardiovascular disease (Adams et al. 2020). Past pandemics have had high levels of inequity for Māori, with significantly higher death rates during the 1918 influenza pandemic and higher hospitalisation and death rates during the 2009 H1N1 pandemic (Haidari et al. 2006; Baker et al. 2009; Wilson et al. 2012) For these reasons, concerns were raised very early on by Māori academics, researchers and health professionals about the impacts of the COVID-19 pandemic on Māori whānau and communities, and whether the whole-of-government response included appropriate planning and implementation of strategies to protect Māori (Espiner 2020; Jones 2020; McLeod et al. 2020; Webb-Liddall 2020).

The current survey is one part of a multi-method project investigating views towards, and factors influencing individuals' ability to adhere to public health advice and government responses to COVID-19. Data collection for the multi-method project spans the period from April to September 2020 and involves a cross-sectional population survey, a longitudinal survey, a focus group and individual semi-structured interviews. This paper reports on the results of the cross-sectional population survey designed to identify people's views on, and factors effecting adherence to government-imposed physical distancing requirements during Alert Level 4 lockdown through until the end of Alert Level 2 in May 2020. We hypothesised that participants' capacity to adhere to distancing requirements might vary according to demographic descriptors (such as occupation).

Materials and methods

Participants

Respondents in the current survey had completed two past Ministry of Health surveys: most recently the COVID-19 Health and Wellbeing Survey (NZ-HWS) that commenced 30 March 2020 (Ministry of Health 2020), and prior to that, the annual New Zealand Health Survey (NZHS) (Ministry of Health 2019). The NZ-HWS (86% response rate) was designed to gather information to support the government's response to COVID-19 and included past participants in the NZHS who had consented to being contacted for future research (Ministry of Health 2020). The NZHS provides a snapshot of the health of New Zealanders that includes health behaviours, health status and access to health care. It uses a stratified, multi-stage sampling design (80% response rate), but

with proportionately fewer Asian and Pacific respondents than the population and is limited to people who can speak English (Ministry of Health 2020).

The current survey invited NZ-HWS participants to take part in an online extension survey: those who were interested were provided with a web-link to the current survey that allowed for data linkage back to demographic and health information collected in the NZ-HWS and NZHS. Respondents did not receive any incentives for taking part in the survey.

This research was approved by the University of Otago Human Ethics Committee (ref: D20/107). Research consultation was undertaken with the University of Otago Ngāi Tahu Research Consultation Committee (ref: 5745_21723).

Survey development and data collection

Questions in the current survey were drawn from several sources, including items devised by the study team, items from an international survey being carried out by Ipsos (a market and social research company) and items from the Ministry of Health. The survey included collection of demographic information, household composition, experience of symptoms and contact with COVID-19 cases. Respondents were also asked about their views towards measures implemented to slow the spread of infection, adherence to preventative measures, and factors impacting on the ability to practice physical distancing. Data on the use of, and views towards facemasks, contact cards and apps to assist with contact tracing were also collected (but are not reported here).

The survey was administered via the Qualtrics online survey platform. Invitations and survey tools were set up and administered by Ipsos. Invitations to the survey were sent in fortnightly waves to a randomly selected group of former NZHS participants, with a first reminder sent within ten days, and a second reminder sent the following week. Responses were aggregated by Alert Level (based on the date of response) during the data collation phase. Survey data collection began on 24 April 2020 when the country was at Alert Level 4 (24–28 April 2020), and continued through Alert Level 3 (29 April to 14 May 2020), Alert Level 2 (15 May to 8 June 2020) and Alert Level 1 (9 June to the end of data collection on 23 July 2020). This paper focusses on data on views on physical distancing measures, ability to practice physical distancing and factors affecting this practice. Many of the items were not asked during Level 1, so only respondents completing surveys during Levels 4, 3 and 2 are included in analyses in the current paper (spanning the period 24 April to 8 June 2020). Each participant is included only once in the analysis.

Data cleaning and analysis

Data were imported into SAS 9.4 (SAS Institute, Cary, NC) for cleaning and analysis. Post-stratification weights were used to achieve better representativeness of the NZ adult population (defined as aged 15+ using 2018 census) given over- and under-representation of some population groups in the achieved survey sample. These weights were calculated using R 4.0 (R Institute, Vienna, Austria), with weighting by age group, gender, and ethnicity (Māori and non-Māori ethnicity), with weighting calculated within each Alert Level.

'NZDep13' (New Zealand Deprivation Index 2013) is a small-area measure of socio-economic deprivation based on 2013 NZ Census data (Atkinson et al. 2014) assigned to each respondent based on their residential address. Deprivation is scaled from 1 to 10 where 1 is least, and 10 most deprived. Selected demographic variables were re-coded including age (10 and 20-year age bands), NZDep13 (quintiles 1–5), household composition (live alone, with one other, two-four others, five or more others). For describing the respondent profile, ethnicity was reported as total count (i.e. an individual identifying with multiple ethnic groups is counted in each group). For analyses involving comparison of outcomes by ethnicity, we used two groupings (Māori and non-Māori) as there were insufficient numbers of respondents identifying as Pacific or Asian to report estimates for these groups (numbers insufficient for both calculation of weights and for estimation of response profiles for these groups). Responses to Likert scale questions were combined for some survey items (e.g. 'strongly agree' and 'tend to agree', 'very effective' and 'effective', as indicated in the Results section).

Weighted proportions of respondents' views and behaviours were calculated at specific Alert Levels and reported with 95% confidence intervals (95% CIs). Logistic regression models were conducted to compare responses to selected survey items with adjustment for confounding by key demographics (age, gender, ethnicity and NZDep2013) as well as adjustment for Alert Level where appropriate. Analyses accounted for the post-stratification weights using the PROC SURVEYFREQ and PROC SURVEYLOGISTIC procedures in SAS.

Sample size calculation

Initial projections for this study (originally planned as a standalone survey) aimed for recruitment of 400–600 people per study period (Alert Level) to return a margin of error of 4–5 percentage points on responses (e.g. estimates of proportions of people holding a particular view or reporting a particular behaviour). The final study design used secondary recruitment from the NZ-HWS, and so recruitment numbers were effectively dependent on recruitment in the NZ-HWS and subsequent entry into the current study, and the duration of each Alert Level. The achieved sample sizes (see results) were in excess of 600 for all Alert Levels.

Results

Participant characteristics

During the data collection period across Alert Levels 4, 3, and 2, 5884 individuals were invited to participate in the survey and 2407 (41%) agreed to take part and completed a survey. Note that all reported percentages described in this section are weighted percentages (with the exception of those describing patient characteristics specified in the paragraph below).

Table 1 presents the demographic characteristics of all respondents across Alert Levels. The unweighted percentages show the share of the respondent sample (e.g. Māori comprised 12.2% of the sample) while weighted percentages show how each group contributes to the estimates in subsequent tables (e.g. Māori corresponded to

Table 1. Demographic characteristics of survey respondents.

Demographic characteristic	Unweighted (n = 2407)	%	
		Unweighted	Weighted
Age-group (years)			
15–24	94	3.9	9.0
25–34	279	11.6	24.9
35–44	367	15.3	14.0
45–54	451	18.7	18.1
55–64	496	20.6	13.7
65+	715	29.7	20.1
Unknown	5	0.2	0.2
Gender			
Male	914	38.0	48.9
Female	1491	61.9	51.0
Gender diverse	1	<0.1	0.1
Unknown	1	<0.1	0.1
Ethnicity (total count)			
Māori	294	12.2	13.9
Pacific	38	1.6	2.0
Asian	131	5.4	8.1
All others	1955	81.2	76.4
NZDep2013 quintiles			
1 (Dep 1–2) least deprived	469	19.5	18.0
2 (Dep 3–4)	533	22.1	21.3
3 (Dep 5–6)	479	19.9	19.7
4 (Dep 7–8)	506	21.0	21.4
5 (Dep 9–10) most deprived	420	17.5	19.6
Household composition			
Lives alone	432	18.0	13.7
With 1 other person	836	34.7	30.4
With 2–4 others	1015	42.2	49.3
With 5 or more others	124	5.2	6.6
Essential worker	582	24.2	26.2
Respondent or household member in high-risk group for influenza[a]	1324	55.0	46.7

[a]High-risk is defined here as aged 65 years and over, and/or eligible to receive funded influenza vaccine due to chronic respiratory disease, chronic heart disease, chronic kidney disease, chronic liver disease, chronic neurological disease, diabetes immunosuppression due to disease or treatment, dysfunction of the spleen, higher weight (Body Mass Index of 40 and above).

13.9% of the weighted estimates). The survey response profile had under-representation for young people (ages 15–24 years), males, Pacific and Asian ethnic groups. While half of the samples were aged 55+, the share of the adult population for this age group was closer to a third (34%) when weighting was applied. Essential workers made up one-quarter of the sample, 86.3% lived with at least one other person (weighted proportion), and just under half (weighted proportion 46.7%), reported that they, or another household member fell into a 'high risk' group for influenza (see footnote to Table 1 for definition).

Participant views on government measures to promote physical distancing

Table 2 presents views on the efficacy of specific measures designed to promote physical distancing and slow the spread of COVID-19. Overall, all these measures were deemed effective or very effective by almost 90% of respondents (or greater) at each Level, with the exception of staying home for 14 days if a household member had mild respiratory symptoms. Although a high proportion of participants who responded to the

Table 2. Number, percentage and 95% CIs of respondents deeming measures implemented to slow the spread of COVID-19 across Alert Levels as 'effective' or 'very effective' (at Alert Levels 4, 3 and 2).

Measure	Level 4 (n = 657)		Level 3 (n = 875)		Level 2 (n = 875)	
	n[b]	Weighted % (95% CI)	n[b]	Weighted % (95% CI)	n[b]	Weighted % (95% CI)
Limiting contact with others						
Reducing the number of people you meet	638	97.0 (95.4–98.5)	858	98.0 (96.9–99.1)	849	97.7 (96.9–98.6)
Avoiding crowded places	647	98.5 (97.4–99.6)	862	99.0 (98.4–99.5)	857	97.7 (96.5–98.9)
Stay at home except for essential activities	636	97.2 (95.9–98.5)	829	95.1 (93.4–96.7)	836	95.0 (93.1–96.9)
Public venue closures						
School closures	613	93.7 (91.7–95.8)	784	89.9 (87.4–92.4)	795	91.3 (89.1–93.4)
Closing bars, restaurants, cinemas etc.	640	97.3 (95.9–98.7)	852	97.7 (96.5–98.9)	848	96.3 (94.6–98.0)
Travel restrictions						
Banning the use of public transport	597	90.8 (88.3–93.4)	772	88.6 (86.0–91.2)	773	89.0 (86.6–91.4)
Banning travel within NZ	626	94.8 (92.8–96.9)	792	90.7 (88.3–93.1)	766	87.5 (84.9–90.1)
Banning international travel into NZ	647	98.3 (97.1–99.5)	864	98.6 (97.4–99.7)	859	98.0 (96.9–99.2)
Staying home when sick						
Stay home for 7 days if you have a mild symptom[a]	594	90.3 (87.6–92.9)	772	88.9 (86.6–91.3)	764	87.6 (85.0–90.2)
Stay home for 7 days if you have more severe symptoms[a]	598	91.1 (88.6–93.6)	800	92.3 (90.4–94.1)	815	93.1 (91.0–95.1)
Stay home for 14 days if someone else in your household has mild symptoms[a]	575	88.6 (86.0–91.2)	750	86.1 (83.4–88.8)	724	82.5 (79.5–85.6)
For 14 days if someone else in your household has severe symptoms[a]	613	93.7 (91.6–95.7)	816	94.4 (92.9–95.9)	805	91.5 (89.2–93.8)

[a]Mild symptoms were described in the question as 'such as a mild cough'. Severe symptoms described as a cough or high temperature.

[b]Note that the percentages of people responding 'don't know' were small for all these items. For items related to reducing contact with others fewer than 1% of respondents answered 'don't know', and for all other items, don't know responses ranged from 0% to 4%.

survey during Level 2 still viewed these measures as effective or very effective, there were small reductions in support for some items when compared with responses during Levels 4 and 3.

Limiting contact with others

Measures to limit contact with others, including reducing the number of people you meet and avoiding crowded places, were perceived as effective or very effective across all Levels by 97%–99% of respondents. During Level 4, 97.2% of respondents thought staying home for all but essential activities was effective or very effective in slowing the spread of COVID-19, with a small decline to 95% during Levels 3 and 2.

Staying home when sick

The suggestion to stay home for seven days if sick with severe symptoms was deemed effective or very effective by most participants (91%–93% across Levels) with slightly higher endorsement compared to the question on staying home if sick with mild symptoms, which declined slightly over the Levels. Similarly, staying home if a household member had severe symptoms was believed to be effective or very effective by a higher proportion of respondents than if a household member had mild symptoms.

Public venue closures

Close to 97% of respondents at all three Alert Levels thought that the closure of bars, restaurants and cinemas (and other similar venues) was effective or very effective in slowing the spread of COVID-19. Closure of schools was viewed as effective or very effective by 93.7% of respondents at Level 4, with a slight decrease in Levels 3 and 2 – 90%–91%.

Travel restrictions

Banning the use of public transport was seen as effective or very effective by close to 90% of respondents across Alert Levels. Banning travel within NZ was viewed as effective or very effective by 94.8% of respondents at Level 4, declining slightly to 90.7% in Level 3 and to 87.5% in Level 2 (when regional travel was permitted again). Support for banning international travel remained high across Alert Levels, with 98% of respondents deeming this measure effective or very effective in slowing the spread of COVID-19.

Support for physical distancing measures

Participants were asked about their level of agreement with three broad statements about overall measures taken by the Government, physical distancing strategies and their understanding of what distancing measures were required (Table 3, see supplementary Table 1 for a detailed breakdown of response options). Most respondents agreed or strongly agreed that they had a good understanding of the physical distancing required in the past 7 days (ranging from 94.8% at Level 4 to 92.9% at Level 2). The majority of respondents (89.4% overall) agreed or strongly agreed that 'the government's physical distancing strategy was the right approach' at the time of responding, with little variation across Alert Levels. When asked to respond to the statement 'The measures currently being taken are greatly exaggerated/too extreme,' the proportion of respondents who disagreed or strongly disagreed reduced from 77.8% (Level 4) to 65.1% (Level 2), indicating greater support for measures being taken during the earlier stages of the pandemic response.

Table 3 also presents the results of three separate logistic regression models, each performed to examine associations between key demographic characteristics and endorsement of one of three statements related to the government physical distancing measures. Odds ratios [OR] in Table 3 and below are mutually adjusted for all other variables in each model. Compared with the older age group (55 years and over), those aged 35–54 had lower odds of agreement with the statement 'In the last 7 days I feel I have a good understanding of the physical distancing required' (OR 0.55, 95% CI 0.37–0.82), as did those in the most deprived NZDep quintile 5 (OR 0.44, 95% CI 0.23–0.83, reference level quintile 1). No other substantive differences were observed in responses between Alert Levels, between ethnic groups (Māori compared to non-Māori) or between genders. The odds of responding favourably to the statement 'The Government's physical distancing strategy is the right approach at this time' did not substantially differ by any of the characteristics in the model (Alert Level, age, gender, ethnic group and NZDep). The odds of disagreement with the statement 'The measures currently taken are greatly exaggerated/too extreme' decreased across Alert Levels, with the lowest level of disagreement observed at Level 2 (OR 0.55, 95% CI 0.41–0.72). Females were more likely than males to disagree with this statement (OR 1.75, 95% CI 1.41–2.17).

Table 3. Results of logistic regression analyses performed separately for factors associated with agreement with three statements about government strategies and measures to promote physical distancing (at Alert Levels 4, 3 and 2).

	Total *n* = 2388	In last 7 days I feel I have a good understanding of the physical distancing required *Tend to agree/ strongly agree*[b]			The Government's physical distancing strategy is the right approach at this time *Tend to agree/ strongly agree*[b]			The measures currently being taken are greatly exaggerated/too extreme*Tend to disagree/strongly disagree*[c]		
Factor[a]	*n*	*n* with response	Weighted % (95% CI)	Odds ratio (95% CI)	*n* with response	Weighted % (95% CI)	Odds ratio (95% CI)	*n* with response	Weighted % (95% CI)	Odds ratio (95% CI)
Alert level										
Level 4	652	623	94.8 (92.8–96.7)	1	592	89.8 (92.6–87.0)	1	512	77.8 (74.1–81.5)	1
Level 3	868	835	94.5 (92.4–96.6)	0.92 (0.53–1.62)	796	91.1 (93.4–88.8)	1.20 (0.80–1.83)	627	71.7 (67.9–75.4)	0.74 (0.56–0.98)
Level 2	868	817	92.9 (91.0–94.9)	0.70 (0.43–1.15)	759	87.5 (90.0–85.0)	0.79 (0.53–1.15)	574	65.1 (61.2–69.1)	0.55 (0.41–0.72)
Age group										
15–34	369	353	94.5 (91.9 – 97.0)	0.90 (0.51–1.58)	338	90.7 (93.9–87.6)	1.19 (0.78–1.84)	273	71.7 (66.7–76.8)	1.12 (0.85–1.52)
35–54	809	759	92.0 (90.0–94.1)	0.55 (0.37–0.82)	721	87.9 (90.4–85.4)	0.85 (0.63–1.15)	596	72.9 (69.6–76.2)	1.22 (0.98–1.49)
55+	1205	1158	95.6 (94.4–96.8)	1	1083	89.6 (91.4–87.9)	1	839	69.8 (67.2–72.5)	1
Gender										
Male	907	856	93.0 (91.0 – 95.0)	1	802	88.3 (90.7–85.8)	1	596	66.0 (62.2–69.8)	1
Female	1479	1417	95.1 (93.9–96.3)	1.46 (0.97–2.18)	1344	90.8 (92.4–89.2)	1.32 (0.98–1.80)	1117	77.0 (74.7–79.3)	1.75 (1.41–2.17)
Ethnicity										
Māori	291	271	92.5 (89.1–95.8)	0.87 (0.50–1.52)	261	90.1 (94.4–85.9)	1.06 (0.63–1.77)	206	69.7 (62.7–76.7)	0.88 (0.62–1.27)
Non-Māori	2097	2004	94.3 (93.1–95.6)	1	1886	89.4 (90.9–87.8)	1	1507	71.8 (69.5–74.1)	1

NZDep2013 quintiles										
1	466	444	95.2 (93.0–97.3)	1	422	90.9 (93.7–88.1)	1	322	68.3 (63.1–73.4)	1
2	531	510	95.4 (93.4–97.5)	1.04 (0.54–2.03)	474	88.8 (91.9–85.7)	0.78 (0.49–1.25)	369	69.9 (65.3–74.4)	1.02 (0.74–1.39)
3	474	457	96.1 (94.4–97.9)	1.24 (0.64–2.44)	422	88.2 (91.7–84.7)	0.72 (0.45–1.16)	339	70.1 (65.1–75.1)	1.08 (0.77–1.49)
4	504	478	93.7 (91.0–96.4)	0.74 (0.39–1.41)	455	90.0 (93.2–86.9)	0.93 (0.57–1.51)	393	77.7 (73.2–82.3)	1.64 (1.15–2.33)
5	413	386	89.9 (86.1–93.7)	0.44 (0.23–0.83)	374	89.6 (93.2–85.9)	0.81 (0.48–1.35)	290	71.0 (65.7–76.2)	1.16 (0.82–1.67)

[a]Respondents with missing age ($n = 5$), unknown gender ($n = 1$) and gender diverse ($n = 1$) were excluded from this analysis.

[b]Respondents answering 'neither agree nor disagree' were combined with those disagreeing with this statement. Odds ratio is for answer of 'Tend to agree/strongly agree' compared to a reference level comprising responses of 'neither agree nor disagree', and 'Tend to disagree/strongly disagree'.

[c]Respondents answering 'neither agree nor disagree' were combined with those agreeing with this statement. Odds ratio is for answer of 'Tend to disagree/strongly disagree' compared to a reference level comprising responses of 'neither agree nor disagree', and 'Tend to agree/strongly agree'.

Participants' physical distancing behaviour when out in public in the past 7 days

Maintaining a 2-m distance from people outside of one's bubble or household was a requirement at Alert Levels 4, 3 and 2. In total, 2233 of the 2407 respondents (91.8% weighted) had left their apartment or property in the past week, with significantly increasing proportions doing so as the Alert Levels decreased. This equated to weighted percentages of 86.7% having been out in public at Alert Level 4 (576 of 657 respondents), 91.9% of respondents at Alert Level 3 (808 of 875) and 95.1% at Alert Level 2 (849 of 875). Questions about physical distancing practices were only asked of individuals who reported having left their house. Reported practice of 2-m distancing behaviour declined over time (Supplementary Table 2), with respondents at Alert Level 4 reporting more consistently maintaining a 2-m distance than respondents at Alert Levels 3 and 2. At Alert Level 4, 57.6% of respondents reported having kept a 2-m distance from 'people outside of their bubble/household', 44.7% always kept a 2-m distance from others at the supermarket, and 79.3% reported having always kept that distance from others when at locations such as the bank or pharmacy. When combining responses for keeping a 2-m distance 'always' or 'most of the time' 90% or more did so for each of the three scenarios presented (Supplementary Table 2).

Factors impacting on the ability to physically distance from others in public

Of the 2233 participants who reported having visited public places in the past 7 days, 1052 (50.1% weighted, 95% CI 47.7–52.5) reported one or more reasons for experiencing difficulties maintaining a safe distance from others. Table 4 presents the number and percentage of respondents citing each type of reason as a factor impacting on their distancing ability at Alert Levels 4, 3 and 2, with similar types of reasons grouped together. The two major reasons given for difficulties practicing physical distancing were due to difficulties arising with distancing in public settings and being an essential worker. More than a third of respondents at Level 4 and 3 (38.4%–41.0%) indicated that one or more factors related

Table 4. Reasons cited by respondents who had difficulties practicing safe physical distancing when in public in the past 7 days (at Alert Levels 4, 3 and 2).

Reason cited	Level 4 ($n = 576$)		Level 3 ($n = 808$)		Level 2 ($n = 849$)	
	n	Weighted % (95% CI)	*n*	Weighted % (95% CI)	*n*	Weighted % (95% CI)
Difficulty distancing in public[a]	202	38.4 (33.9–42.9)	316	41.0 (37.0–45.1)	264	32.8 (29.0–36.6)
I am an essential worker	108	20.9 (16.9–24.8)	148	19.8 (16.3–23.3)	84	9.5 (7.1–11.9)
I have shared childcare custody arrangements	17	2.9 (1.3–4.5)	25	3.5 (2.0–5.0)	11	1.6 (0.5–2.7)
I had an emergency and had to leave my bubble/household	16	2.9 (1.2–4.6)	32	3.3 (2.1–4.6)	6	0.6 (0.1–1.2)
I visited one or more other people for personal reasons	14	1.9 (0.9–2.9)	25	3.6 (1.8–5.3)	45	6.2 (4.0–8.5)
Other factors[b]	4	1.0 (0.0–2.2)	14	2.3 (0.8–3.7)	14	2.3 (0.8–3.8)

[a]'Difficulty distancing in public' includes the following items: Physical distancing hasn't been possible on public transport I have used/or in public areas I've visited; People around me not taking distancing seriously/or have not observed distancing when engaging in recreation or exercise in public place/or observed distancing at public areas visited; Nowhere to exercise/engage in recreation locally where distancing can be maintained. Data for individual items are presented in Supplementary Table 3.

[b]'Other factors' includes the following: Physical distancing does not fit with my cultural practices/tikanga; My whare/house was so crowded I had to shift to another bubble/'household; It was not safe for me to stay in my 'bubble' because of the behaviour of others as well as a range of reasons noted in free text comments. Data for individual items are presented in Supplementary Table 3.

Table 5. Logistic regression analysis of factors associated with difficulties practicing physical distancing when in public in the past 7 days (at Alert Levels 4 and 3).

	Any difficulties physical distancing ($n = 740$)		Adjusted logistic regression model
Factor	n with response	Weighted % (95% CI)	Odds ratio (95% CI)
Alert Level			
Level 4	298	55.3 (50.8–59.8)	1
Level 3	442	57.8 (53.7–61.8)	1.09 (0.83–1.42)
Age group			
15–34	142	65.8 (58.9–72.6)	2.08 (1.44–3.01)
35–54	279	57.9 (53.2–62.5)	1.32 (1.01–1.73)
55+	319	46.2 (42.3–50.0)	1
Gender			
Male	275	55.9 (50.9–60.9)	1
Female	465	57.2 (53.7–60.8)	1.16 (0.88–1.52)
Ethnicity			
Māori	104	63.2 (54.9–71.5)	1.19 (0.78–1.83)
Non-Māori	636	55.5 (52.2–58.8)	1
NZDep2013 quintile			
1	129	47.7 (40.9–54.5)	1
2	160	55.2 (48.9–61.5)	1.42 (0.95–2.12)
3	161	63.6 (57.2–69.9)	1.74 (1.14–2.65)
4	158	59.5 (52.9–66.0)	1.39 (0.90–2.15)
5	132	55.8 (48.1–63.5)	1.16 (0.72–1.85)
Essential worker[a]			
Yes	285	83.0 (78.5–87.4)	5.53 (3.86–7.93)
No	447	1.0 (43.4–50.6)	1

[a]This analysis excludes 8 individuals for whom essential worker status was unknown.

to others' behaviour in public places, or the nature of the public place limited their ability to safely distance from others, decreasing somewhat to 32.8% for respondents at Level 2. Around 20% of respondents at Levels 3 and 4 reported that being an essential worker impacted on their distancing ability, with fewer reporting this at Level 2 (9.5%). See Supplementary Table 3 for the detailed set of responses prior to grouping.

Logistic regression models examined associations between demographic characteristics and reporting any difficulties practicing physical distancing when in public (i.e. any reason listed in Table 4) and are presented in Table 5. This analysis was restricted to Levels 4 and 3 (total $n = 1384$ who had visited a public place in past 7 days), as distancing requirements were substantially different at Level 2. In total 740 participants (56.6%, 95% CI 53.5–59.6) reported at least one or more reasons it was difficult to maintain physical distancing. Characteristics of respondents associated with reporting one or more reasons for difficultly practicing physical distancing included age, NZDep and being an essential worker. Compared with those aged 55+, all younger age groups were more likely to report difficulties distancing. Likewise, those in more deprived groups (quintiles 3 and 4 in particular) were also more likely to report difficulties than those in least deprived groups. No substantial differences were observed by gender or between Māori and non-Māori.

Discussion

Main findings

The overwhelming majority of survey participants were supportive of the government public health measures implemented to promote physical distancing across Alert

Levels 4, 3 and 2. Few differences were observed in views or behaviours in relation to the demographic characteristics of respondents. This suggests that for most respondents, there were high levels of understanding and willingness to adhere to requirements during lockdown and beyond. Most agreed that measures such as staying home when sick, limiting contact with other people outside your 'bubble', public venue closures, and travel restrictions were appropriate and effective in slowing the spread of COVID-19. These findings are consistent with levels of acceptance of and support for distancing measures reported in Australia (Kayes et al. 2020), Germany, Italy, and the Netherlands (Meier et al. 2020) during the first wave of the pandemic in those countries. The belief in the efficacy of public health measures, and trust in the agencies implementing them, have been shown to be important contributors to compliance with such measures (Janz and Becker 1984; Verelst et al. 2016; Briscese et al. 2020). Most participants thought that if someone was sick with severe symptoms then staying home was effective or very effective; however, this perceived effectiveness declined slightly with respect to mild symptoms. This speaks to the need to be clear in messaging that staying home is effective for all symptoms, whether severe or mild.

The majority of those surveyed had left their homes in the past week (permitted for essential workers, to access essential services, and for exercise locally), and most reported having practiced regular physical distancing when out in public. Overall distancing behaviour, and levels of support for these measures, declined over time as Alert Levels decreased, despite ongoing recommendations to maintain a 2-metre distance from people outside your household. During Alert Level 3 most of the more stringent restrictions imposed at Level 4 remained in place, but daily confirmed and probable case numbers were low, ranging from zero to six cases identified in the community (NZ Doctor 2020). Few differences were found between respondent views participating at Levels 4 and 3. However, by Alert Level 2, when cases of community transmission were very minimal (NZ Doctor 2020), participants had lower levels of agreement that the current government response was appropriate (but still substantially high) and fewer had 'always' practiced 2-m distancing in the past week. This reflects the influence of temporal context on participant responses and suggests that some people may have become more complacent as perceived risk levels within NZ declined. Fewer respondents viewed travel restrictions within NZ as effective or very effective as Alert Levels dropped, but support for a ban on international travel into NZ remained high across all Levels, presumably due to the risk posed by ongoing high rates of infection overseas.

While this study did not directly assess perceptions of risk, it is likely that as rates of community transmission and associated Alert Levels decreased, the perception of risk of exposure and consequent infection also decreased, in turn impacting on distancing behaviour. A recent assessment of public risk perception of COVID-19 in ten countries across Europe, America, and Asia found that despite variability across cultures, risk perception was significantly correlated with the adoption of preventative health behaviours such as hand washing, face mask use, and physical distancing in all countries (Dryhurst et al. 2020). This finding highlights the importance of ongoing public health messaging to remain vigilant at an individual and community level, and to maintain personal preventative health behaviours even in the absence of community transmission.

Around half of all participants reported having had difficulties physically distancing. Key reasons behind this included being an essential worker, and challenges related to the

behaviour of others and inability to distance in some public places. Such factors are likely to impact on levels of self-efficacy, or belief about the ability to perform the recommended action (Chong et al. 2020; Norman et al. 2020). While not directly explored in this study, self-efficacy may partially explain some of the findings reported here. For example, the odds of facing challenges with physical distancing were more than five times greater for essential workers. This reflects the higher level of risk that some individuals (and their families) faced whilst fulfilling a wide range of essential roles during lockdown for the benefit of the rest of society (Editorial (The Lancet) 2020), and indicates a need for more effective policies and practices to prevent infectious disease transmission in the workplace. Younger people and those in more deprived groups also reported more difficulties practicing physical distancing that might be explained by broader contextual factors for these groups (e.g. accommodation with shared spaces) that may affect actual or perceived ability to maintain physical distancing.

The current survey did not specifically ask participants about their information needs or views on specific aspects of public health communications about COVID-19. However, our findings suggest that participants had a clear understanding of what was required of them in terms of distancing behaviours, and for most people self-reported behaviours aligned well with public health requirements. This indirectly suggests that the information and advice provided across Alert Levels were clear and well understood by participants in the current study. This assumption is consistent with the findings of an online survey conducted in NZ by researchers at Massey University post lockdown (Thaker and Menon 2020). Participants gave very favourable ratings to the way in which the Prime Minister and Director-General of Health communicated relevant information during the pandemic, for example about Alert Levels, lockdown rules and the availability of essential services (Thaker and Menon 2020). The study authors concluded that 'New Zealand had timely communication from trusted leaders who the public felt connected to. There was a feeling of unity and a sense that we had a leader looking after us' (Massey University 2020).

Strengths and limitations

Strengths of this survey include a large, national population-based sample (over two thousand participants), and inclusion of participants from wide-ranging sociodemographic backgrounds. The survey began in the final days of Alert Level 4 lockdown and continued to run until Alert Level 1, and so the results provide important insight into respondents' views and behaviours from the very early stages of New Zealand's response to the pandemic through lower Alert Levels. Collection of data in real time throughout Alert Levels reduced the potential for recall bias (relative to a study conducted after the lockdown period) and allowed for comparison of respondent views and behaviours both within and between Alert Levels. Respondents generally completed the entire survey, with only a small number of missing, don't know or refused responses for the questions analysed in this paper.

The study sample was recruited from participants who had previously participated in two Ministry of Health surveys (the NZHS and subsequent NZ-HWS), so is potentially made up of a more 'compliant' group of individuals. While the original sample (NZHS participants) is nationally representative, response rate profiles for the subsequent NZ-

HWS and current survey meant that respondents completing the survey reported here are likely to differ from the general population in ways that may limit the generalisability of the study findings to NZ's population. Some of the impact of this recruitment process will have been corrected through the post-stratification weighting (by age, gender, and ethnicity) which will address over-representation of females and older people in the study sample; but further differences between respondents and non-respondents will still be influencing the responses (e.g. if there was selection bias towards individuals who were supportive of government response, either in this survey or in the NZ-HWS). While weighting was able to adjust the study results to allow for the older profile of participants, it is still important to note that the overall age profile in New Zealand is oriented towards older people (about 40% of the adult population are aged 55+) and hence results may not generalise to other settings with a younger age profile. Survey respondents were limited to those who speak and read English. Only a small number of participants identified as Asian or Pacific ethnicities, so we were unable to consider the views or behaviours of these groups. For some other aspects (e.g. essential worker status) there are no readily available national population benchmarks against which to measure participation in this survey. Finally, sample sizes for between-group comparisons were often relatively small (e.g. by ethnicity or NZDep quintile) which means that these comparisons were somewhat imprecise from a statistical perspective: this is reflected in confidence intervals for proportions and odds ratios, and in some cases, the results are potentially consistent with relatively substantial differences between these groups (i.e. in these cases we can't rule out a larger difference).

The survey found no clear differences in response patterns for Māori compared with non-Māori with respect to perceived effectiveness of public health measures, or ability to practice appropriate physical distancing. However, the relatively small number of Māori respondents in the sample means we cannot rule out the potential for reasonable size differences between Māori and non-Māori in experience of some of these pandemic response elements. Other local research has shown that the wider social, economic, health and wellbeing impacts of lockdown have differentially impacted Māori (Thaker and Menon 2020).

Conclusions

The success in eliminating community transmission following the March–April 2020 lockdown period was not only due to the stringent public health measures that were put in place (Baker et al. 2020; Cousins 2020), but also thanks to the NZ population's willingness to play their part by rapidly adopting behavioural change in line with government requirements. This helped to ensure NZ's population infection and mortality rates remained low, and we have so far avoided an overburdened health system. Accompanying government measures, such as the COVID-19 financial support packages, includes a COVID-19 leave support scheme (designed to support employers to continue payments to employees advised to self-isolate who are unable to work from home) and a short-term absence payment (for workers needing to stay home for 1–3 days awaiting a COVID-19 test). Going forward there will be a need to examine sickness leave support to ensure people with mild symptoms feel able to stay home. This study addresses several gaps in our understanding of how the NZ population was able to adapt to the strict

measures imposed on the nation as it went into its first period of lockdown. Survey findings align with the observed success of the measures that were imposed to achieve safe physical distancing to reduce the spread of COVID-19. High levels of support for, and adherence to the government's physical distancing strategies were reported by survey participants, reflecting the way in which New Zealanders followed restrictions and adapted to incorporate physical distancing measures into their everyday lives during lockdown in early 2020 and beyond.

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