Exploring the effects of COVID-19 restrictions on wellbeing across different styles of lockdown

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Abstract

Countries have instigated different restrictions in response to the COVID-19 pandemic. For instance, nationwide, strict "lockdown" in Scotland was enacted with breaches punishable by law, whereas restrictions in Japan allowed for travel and interaction, with citizens *requested* rather than *required* to conform. We explored the impact of these differential strategies on health behaviours and wellbeing. In February 2021, 138 Scottish and 139 Japanese participants reported their demographic information, pandemic-induced health behaviour-change (alcohol consumption, diet, perceived sleep quality, physical activity), negative mood, and perceived social isolation. Scottish participants' health behaviours were characterised by greater change (typically negative), most likely due to greater lifestyle disruption, whereas Japanese participants' behaviours were more-stable. Negative changes to health behaviours were typically associated with poorer mental wellbeing and isolation. Interestingly though, Japanese participants reported greater negative mood but not isolation despite the less-restrictive lockdown. Taken together, different lockdown styles led to different changes in health behaviours.

Keywords

COVID-19, lockdown, health behaviours, mental health, mood, wellbeing

Introduction

Stay-at-home orders, or "lockdowns", have played a vital role in controlling the spread of the COVID-19 virus internationally. Different countries have chosen to implement different restrictions to differing degrees, and for differing lengths of time. Countries have also implemented different strategies in the enforcement of restrictions. Highly contrasting strategies of restrictions and enforcement were, for example, implemented in Japan and parts of the UK (specifically Scotland), which we describe later in the Method. The current study examines the effects of different lockdown policies on health behaviours and wellbeing by comparing a highly restrictive, long-lasting, and legally enforceable policy in Scotland to a more open, mild, lockdown policy in Japan,.

Health behaviours (pre- and peri-pandemic)

Previous studies, to be discussed, have already identified associations between health-related behaviours, and

physical and mental health during lockdowns or stay-at-home orders. Studies examining these factors in the first half of 2020 have shown mixed patterns of effects often associated with personal circumstances. Within the current study we examine a cross-section of individuals from countries with two very different styles of lockdown[1] and consider associations between alcohol consumption, diet, sleep, and physical activity and wellbeing, as well as demographic factors.

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Alcohol consumption. Alcohol Change UK (Holmes, 2020) noted early in the pandemic that people were drinking differently during lockdown; that is, some people were drinking more and others less. Research to date has supported this with mixed effects of the pandemic on alcohol use reported. In an extensive review Acuff et al. (2022) reported that whilst mean alcohol intake had remained consistent, 23% of participants reported increases in consumption, whilst 23% reported decreases. Within their review, increases in consumption were related to ethnicity and being female (see also Pollard et al., 2020), and to being younger (see Jacob et al., 2021). Other reviews report a slight trend towards an increase in consumption (Rafailia Bakaloudi et al., 2021; Roberts et al., 2021).

In Scotland, the mixed nature of results was evidenced by Ingram et al. (2021), who noted that whilst 36% of respondents in Scotland were drinking more since the beginning of the pandemic, 25% were drinking less. Examination of personal circumstances suggested that differences arose based on whether participants had children in the home; having children in the home was associated with an increase in alcohol consumption (also seen in Acuff et al., 2022). Investigations of the effects of the pandemic on alcohol consumption in Japan are focused on alcohol-use disorders and suggest that there has been an increase in admissions to hospital for alcohol-related illness due to the COVID-19 pandemic (Itoshima et al., 2021).

Both the problematic (Grant and Harford 1995; Pottenger et al., 1978; Schuckit 2006) and social use of alcohol (Birnbaum et al., 1983; Jones et al., 2007; Parker et al., 1987) have been shown to impact negatively on mental health. Schmits and Glowacz (2021) found that during lockdown participants who were drinking more reported higher levels of anxiety and stress than those who had maintained pre-lockdown consumption levels. Ingram et al. (2020) found no relationship between changes in alcohol consumption and negative mood scores during lockdown conditions in spring 2020.

Diet. The influence of lockdown on diet has also been extensively studied, with mixed results and many studies reporting inconsistent effects (e.g., Ruiz-Roso et al. 2020; Kolokotroni et al., 2021; for a review, see Bennett et al., 2021). However, a further review (Neira et al., 2021) suggests COVID-19 measures have had a clear negative effect on some dietary factors. Ingram et al. (2020) found that in Scotland both positive and negative changes had been made by different individuals; 41% of participants reported a negative change to their diet, whilst 25% of respondents noted a positive change in their diet. When assessing differences across demographic groups, negative changes in diet were associated with a change in work status since the beginning of the pandemic.

Previously reported links between unhealthy eating and poor mental health (e.g., Jacka et al. 2010) have been upheld in peri-pandemic studies. For example, Amatori et al. (2020) reported associations between poorer mood and unhealthy dietary habits in Italy during COVID-19 home isolation. In Japan, Yamamoto et al. (2020) found that participants with mild-to-moderate psychological distress reported less-healthy eating habits than those with no-or-low psychological distress, and those with serious psychological distress reported less healthy eating habits than both other groups. In Scotland, adoption of an unhealthier diet during lockdown was associated with a greater level of negative mood (Ingram et al., 2020).

Sleep. Research findings surrounding quality and quantity of sleep during the pandemic have also been inconsistent. In Spain, participants' sleep quality typically improved over the period of lockdown (Lopez-Bueno et al., 2020), but elsewhere (e.g., in China and Italy) the COVID-19 pandemic was linked to poorer sleep outcomes (Casagrande et al. 2020; Cellini et al., 2020; Xiao et al., 2020). One meta-analysis suggested around one quarter of participants were experiencing sleep problems during the pandemic (Alimoradi et al., 2021). In Scotland, over half (52%) of respondents reported poorer sleep quality during lockdown, whilst only 17% reported improved sleep quality (Ingram et al., 2020). Across a larger sample from the same population, Janssen et al. (2020) found that participants' hours of sleep generally increased during the strictest months of lockdown and decreased again when lockdown began to ease. Sleep duration was reported to have lengthened during mild lockdown in Japan (Tahara et al., 2021).

Links between stress and wellbeing and sleep problems are well-established (see Sanford et al. 2014 for a review), and research completed during COVID-19 lockdowns further support these finding. Clear associations between sleep difficulties and poor mental wellbeing have been found (Cellini et al., 2020; Yurteri and Sarigedik 2021). In both Scotland and Japan, poorer sleep was related to poorer mental health indicators. Yamamoto et al. (2020) noted that COVID-19-related sleeplessness was higher for participants with mild-to-moderate psychological distress than those with no-or-low psychological distress, and higher again for serious psychological distress than other groups. Ingram et al. (2020) found that any negative change in perceived sleep quality was linked to higher scores for negative mood.

Physical activity. Lockdown conditions were predictably associated with changes in individuals' physical activity, but again reports are inconsistent. In an international review of studies Stockwell et al. (2021) found that the majority of research reported decreases in physical activity and increases in sedentary behaviour during lockdowns. However, some studies from early in the pandemic found that many people were increasing their levels of physical activity whilst under stay-at-home conditions (Di Renzo et al., 2020;

López-Bueno, et al., 2020; Romero-Blanco et al., 2020). Similar results were found in Scotland where, during lockdown conditions, there was a decrease in time spent walking but an increase in moderate to vigorous physical activity (Janssen et al., 2020). Ingram et al. (2020) found that during lockdown, 47% of the sample were doing less physical activity than before the pandemic, whilst 36% more. Individual factors which contributed to these changes included student status – being a student was associated with becoming a lot less physically active. In addition, participants who thought that someone within their household had been infected by COVID-19 were typically a lot less physically active.

Links between engaging in physical activity during COVID-19 lockdowns and better mental wellbeing have been demonstrated through research (see for example Antunes et al., 2021; z; Ginoux et al., 2021). Specific to the current investigation, studies in Japan have shown decreases in physical activity during the period of mild lockdown in individuals over 40 years of age (Makizako et al., 2021; Yamada et al., 2020) and in a stratified sample of participants between 20 and 59 (Koohsari et al., 2021). In Scotland, participants who were engaged in a lot less physical activity during lockdown reported higher negative mood scores (Ingram et al., 2020), whilst in a qualitative study, people with disabilities in Scotland and Canada indicated that their mental wellbeing had been impacted by the lack of physical activity (Kamyuka et al., 2020).

Health behaviours and wellbeing

As discussed, poorer health behaviours have been linked to poorer mental health and wellbeing prior to the COVID-19 pandemic, and this pattern has been shown to continue and potentially be exacerbated for the four behaviours (alcohol consumption, diet, sleep, and physical activity) during the COVID-19 pandemic. Further, the restrictive conditions and social isolation experienced during the COVID-19 pandemic have been shown to lead to or exacerbate mental health and wellbeing irrespective of health behaviours (e.g., Demkowicz et al., 2021; Nogueira et al., 2021), and even lead to poorer cognitive function (Ingram et al., 2021).

Of specific note to the current study, within the highly restrictive lockdown in Scotland, Ingram et al. (2020) have shown that changes to an unhealthier diet, poorer sleep quality, and less physical activity during the pandemic was associated with poorer mental health outcomes, although note that the direction of this relationship has not been established. In Japan, research has demonstrated associations between poorer diet and sleep and poorer wellbeing (Yamamoto et al., 2020).

Whilst it is clear that changes to health behaviours are detrimental to wellbeing in both countries, what has yet to be established is the potential differences in changes to health behaviours and wellbeing which may be attributed to style of lockdown. Further, length of lockdown and the timing of data collection should be considered. Ingram et al. (2020) collected their data at the end of 9.5 weeks of strict lockdown in Scotland, whilst Yamamoto et al. (2020) collected their data at the end of a 5-week mild lockdown in Japan. However, for diet and sleep, the effects of changes to health behaviours on wellbeing seem consistent across style of lockdown and time spent under these conditions. Cultural influences should also be considered; whilst in Japan the policy was to "request" that people refrain from going out rather than mandate a lockdown, it has been suggested that adherence to this request was likely to be high due to high levels of morality within Japanese society (Sieg 2020). In such a case, the experience of isolation for people in mild lockdown in Japan is likely to have equalled that of the stricter lockdown in Scotland.

The current study

Within the current study, we examined the effects of differing lockdown policies on COVID-19-induced changes to health behaviours, and the relationships that these changes had with mental health and wellbeing (as indexed by negative mood scores). We directly compared socio-demographic variables and changes to health behaviours of participants living in Scotland and Japan during their respective phases of lockdown/stay-at-home mandates, beginning January 2021. Consistent with Ingram et al. (2020), we anticipated that in both countries, participants with greater lifestyle restrictions, or who had to make greater changes due to the pandemic, would demonstrate increased incidence of change towards poorer health behaviours (consuming more alcohol, adopting an unhealthier diet, reporting poorer sleep quality, and being less physically active). We also anticipated that those who report negative changes in health behaviours would experience greater negative mood. Finally, we assessed negative mood and perceived isolation across national groups.

Method

Context - the timeline and nature of restrictions in scotland and Japan

Initial COVID-19 lockdown was in place in Scotland from 23rd March 2020 to 28th May 2020.[2] During this period, all but essential work was carried out from home with only the most-essential retail and services open; schools, college, and university campuses were also closed with learners engaging online from home. Travelling outside a region, even between local authorities within Scotland, was allowed only for essential purposes. International travel was also only allowed for essential purposes and was strongly

discouraged. After this time, restrictions were gradually eased over a period of 3 months before increases in infection led to additional measures being gradually reinstated. Towards the end of 2020, further increases in cases, largely due to the spread of the alpha variant (B1.1.7; also known as the Kent variant), within Scotland led to short-notice changes to planned seasonal visiting and a full-scale lockdown beginning on 5th January 2021. Stay-at-home restrictions and bans on travelling (as detailed previously) remained in place until 2nd April 2021 when gradual easing was implemented. Within Scotland breaches of restrictions were outlined as an offense in the Coronavirus (Scotland) Act. Police were given powers designed to reduce the spread of COVID-19 in August 2020, with a penalty of up to £10,000 applicable in some cases.

In contrast to enforced and long-lasting restrictions imposed within Scotland, the approach to stay-at-home orders in Japan has been less forceful (https://www.mext.go.jp/). Seven prefectures within the country went into the first state of emergency, described as "mild lockdown", on 7th April 2020, with the declaration being expanded to the remainder of the country on 16th April, although the number of COVID-19 cases within each prefecture largely differed. At this time a wide range of industries were requested to close, including restaurants and pubs, karaoke boxes, fitness centres, museums, and libraries. Universities introduced online learning for the spring semester, and campuses in big cities had restricted access. Elementary schools, junior high schools, and high schools closed for approximately 3 weeks but gradually reopened at different rates dependent on prefecture. Many nurseries remained open, particularly for parents who worked in hospitals. The Japanese government encouraged companies to let employees work from home, and the number of staff who could work from the office depended on each workplace. Many major sporting events were cancelled in summer 2020, and the Tokyo Olympics and Paralympics were postponed until summer 2021. During this time restrictions were requested rather than enforced with no penalty for breaching guidance.

Easing of restrictions then began shortly over a month later (14th May 2020), and the Japanese government lifted the state of emergency for all prefectures on 25th May. The number of new COVID-19 cases remained low until early summer, but it became threatening again in July 2020 (Okabe, 2020). Although the number of new cases was bigger than in spring 2020, the majority were not considered severe illnesses, so no state of emergency was declared. As cases continued to rise, a second state of emergency was declared and applied to 11 prefectures, including Tokyo, from 8th January 2021 to 21st March 2021. While the first declaration was for all prefectures, the second one was regional and mainly impacted hospitality, in particular businesses which sold alcohol. As during the

first state of emergency, there was no legal penalty even if people violated the guidelines. Although the government encouraged working from home again, many people continued to work from their offices. Schools were kept open, and nationwide university entrance examinations were also held on-site in January, February, and March 2021. Due to the impact of the entrance examinations for universities in Japan, the government did not make any restrictions to travel. As a result, more people crossed borders of prefectures than during the first declaration, including those commuting between prefectures. In contrast to lockdown in Scotland, restrictions in Japan were *requested* rather than *enforced*, with no penalties resulting from violations (e.g., Tahara et al., 2021). Therefore, to what extent employers and business owners, and citizens followed the state of emergency depended on populations, economic situations of each institution, and individual beliefs.

The restrictions imposed on the populations of Scotland and Japan to limit the spread of COVID-19 have differed quantitatively and qualitatively. Individuals in Scotland spent more time under restrictions in both spring 2020 and 2021, restrictions were more limiting and became legally enforceable in summer 2020. In Japan both lockdown periods were shorter, only some parts of the country were affected by the state of emergency in spring 2021 and compliance with guidance was requested. Additionally, in spring 2021 nurseries and schools within Japan remained open, whereas children in Scotland completed learning online during this lockdown. In the week leading up to data collection (data collection was completed over the course of week beginning 1st February 2021) a 7-day rolling average of 1,083 new COVID-19 cases and 19 COVID-19 related deaths were reported in Scotland, and a 7-day rolling average of 3,329 new COVID-19 cases and 91 COVID-19 related deaths were reported in Japan (https://github.com/CSSEGISandData/COVID-19). It is plausible that these two contrasting government responses to the pandemic have had differing degrees of success in containing the spread of the COVID-19 virus and minimizing the impact of lifestyle restrictions on citizens' health.

Participants

A total of 277 adults took part in the study. All were recruited through convenience sampling using paid participant recruitment/survey completion websites (Prolific Academic in Scotland, and CrowdWorks in Japan). The sample included 138 participants (59% female, 41% male; range$_{age}$: 18–69 years, M_{age} = 39.3, SD_{age} = 12.5) who were residents of Scotland (range$_{residence}$: 1–69 years, $M_{residence}$ = 34.2, $SD_{residence}$ = 14.8). A participant recruitment advert was issued via Prolific Academic

(https://prolific.co/), participants entered their postcode to confirm they were resident in Scotland, they were paid £6 in exchange for participation. The sample also included 139 participants (46% female, 53% male, <1% undisoclosed; range$_{age}$: 20–70 years, M_{age} = 39.3, SD_{age} = 9.2) who were resident in Japan (range$_{residence}$: 20–70 years, $M_{residence}$ = 39.1, $SD_{residence}$ = 9.1). A participant recruitment advert was issued via CrowdWorks (https://crowdworks.jp/) and participants were paid ¥850 (equivalent to £6 at the time of data collection). Table 1 presents a breakdown of participant ages for each national group.

A visual inspection of histograms of age data per participant group suggested that both groups were normally distributed around a similar central point. The spread of individual observations was broadly similar across groups. An independent samples t-test revealed that there was no difference between the mean participant ages across groups [$t(275)$ =-0.06, p = .949].

For additional demographics, such as employment status and household type, see Table 2. For information about participants' experiences with COVID-19, see Table 3.

Materials

Questionnaire. We used a multi-purpose questionnaire developed by Ingram et al. (2021). The questionnaire

Table 1. Breakdown of age by nationality.

	Scotland	%Age	Japan	%Age
18–19	4	2.9	0	0.00
20–29	32	23.2	21	15.1
30–39	44	31.9	47	33.8
40–49	24	17.4	54	38.8
50–59	24	17.4	14	10.1
60+	10	7.2	3	2.2
n	138		139	

Table 2. Sample demographics.

Location	*Town*	*City*	*Suburbs*	*Village*	*Countryside*		
Scotland	36%	24%	16%	20%	4%		
Japan	19%	30%	52%	—	—		
Household	*+ adult(s) + child(ren)*	*+ adult(s)*	*+ children*	*Alone*			
Scotland	28%	53%	7%	12%			
Japan	19%	53%	5%	22%			
Child(ren) at home	*Yes*	*No*					
Scotland	47%	53%					
Japan	28%	72%					
Student status	*Student*	*Non-Student*					
Scotland	12%	88%					
Japan	4%	96%					
Employment	*Working from Home*	*Unemployed*	*Furloughed*	*Keyworker*	*Carer/Parent*	*Working Away*	*Undisclosed*
Scotland	44%	14%	7%	20%	8%	5%	1%
Japan	26%	13%	<1%	19%	18%	21%	2%
Employment change	*Yes*	*No*	*Undisclosed*				
Scotland	25%	75%	—				
Japan	21%	78%	<1%				

Table 3. Experience with COVID-19 (throughout the pandemic).

	Scotland			Japan		
Experience	Yes	No	Undisclosed	Yes	No	Undisclosed
Tested positive for COVID-19	<1%	99%	—	—	—	—
Suspected COVID-19	17%	83%	<1%	—	—	—
Member of household tested positive or suspected COVID-19	12%	88%	—	—	—	—
Had to self-isolate	37%	62%	<1%	9%	91%	—
Included in the vulnerable group	11%	88%	<1%	7%	94%	—
Suffered bereavement due to COVID-19	10%	89%	<1%	—	—	—

Note: Questions regarding COVID-19 infection were omitted from the Japanese version of the questionnaire due to cultural sensitivities surrounding this information.

consisted of four sections. The first section pertained to general demographics and gathered the data presented in Table 2. The second section pertained to experience with COVID-19 and gathered the data presented in Table 3. The third section pertained to safety measures and included questions on how often participants would go out in public (and for what reasons), communicate with individuals from a different household (and how), and what measures they were taking to protect themselves and others from COVID-19. The last question in this section asked participants to "*Briefly describe the measures you are taking to protect yourself and others from COVID-19*". This question was specifically included to delineate how differences in lockdown strategies between Scotland and Japan manifested at the individual level. The fourth and final section measured changes in health behaviours. Participants rated changes to their alcohol consumption, diet, sleep quality, and physical activity during COVID-19 lockdown. A 5-point scale was used for all four behaviours (alcohol: 1 = "drinking a lot more", 3 = "about the same", 5 = "a lot less"; diet: 1 = "a lot more unhealthy", 3 = "about the same", 5 = "a lot more healthy"; sleep: 1 = "a lot worse", 3 = "about the same", 5 = "a lot better"; physical activity: 1 = "a lot less", 3 = "about the same", 5 = "a lot more").

Perceived social isolation. Participants rated how socially isolated they felt at that point in time using a 100-point slider scale, with higher scores denoting greater isolation, or fewer opportunities for social contact.

Negative mood. As in Ingram et al. (2020), we selected 10 negative items from Grove and Prapavessis' (1992) abbreviated Profile of Mood State (POMS) scale. The abbreviated POMS scale has a mean subscale inter-correlation of 0.58 (0.53–0.67), mean subscale internal consistency (Cronbach's α) of 0.80 (0.66–0.80), and clear validity (winner-loser differences $p < .001$). Two items, which the authors felt mostly definitively represented the subscale in question, were selected from each of the five sub-dimensions of Confusion (forgetful, unable to concentrate), Tension (anxious, uneasy), Depression (helpless, sad), Fatigue (exhausted, worn out), and Anger (angry, annoyed). Approximations of negative mood items were used in the Japanese version of the questionnaire where literal translations were not available. Participants rated their mood on each of the items *at that point in time* using a 100-point slider scale, with higher scores indicating greater negative mood. For the current data set, a Cronbach's $α = 0.93$ was observed for Negative Mood Score (NMS; $n_{items} = 10$), and the five subscales ranged from $α = 0.69$–0.91, similar to (Ingram et al., 2020; Cronbach's $α = 0.91$, range of subscales $α = 0.69$–0.89) We considered the reliability analysis split by national group

and found that the Scottish participants' responses demonstrated an $α = 0.93$ and Japanese participants' responses an $α = 0.92$ (Scottish sub-scales ranged from $α = 0.64$–0.91 and Japanese sub-scales ranged from $α = 0.65$–0.94).

Procedure

The study received ethical approval from the [institutional ethics committees removed to support blind review] and followed the Helsinki Declaration (1964) and World Medical Association (2013) protocols. All participants provided electronic informed consent prior to the study. The study was designed in Gorilla (https://gorilla.sc) and conducted in the week beginning on 1st February 2021. After agreeing to take part on either Prolific Academic or CrowdWorks participants were redirected to the survey. All participants were asked to complete the study using a desktop or laptop computer rather than a mobile device/tablet. For Japanese participants, all the materials were translated into Japanese by the third author and then checked for accuracy (in conveying the meaning of the original items) by another native Japanese speaker who was otherwise uninvolved in this research.

Data analysis

Participants who identified as non-drinkers were excluded from analyses involving changes in alcohol consumption (25% of the Scottish participants; 54% of the Japanese participants). A set of Pearson's chi-square tests (or Fischer's exact tests if expected cells sizes were problematic) were conducted to examine associations between socio-demographic factors and changes in health behaviours due to COVID-19 lockdown. A set of Spearman's correlation tests (one-tailed) were conducted to explore associations between changes in health behaviours. Positive correlations represented 'positive' changes - reduced alcohol consumption, healthier diet, better sleep quality, and more physical activity. Pearson's correlation tests (one-tailed) were also used examine associations between participants' age, NMS, and perceived social isolation. One-way between-subjects analyses of variance (ANOVAs) were conducted to examine the impact of changes in health behaviours on NMS and perceived social isolation. For transnational comparisons, Pearson's chi-square tests (or Fischer's exact tests if expected cells sizes were problematic) were used to examine associations between national group (Scotland, Japan) and changes in health behaviours. One-way between-subjects ANOVAs were conducted to examine the impact of national group on NMS and perceived social isolation. Throughout the report, we used the significance threshold (α) of 0.05 and reported only significant results. Procedures specific to assumption-testing

Table 4. Associations between socio-demographics and health behaviours.

	Changes in	Alcohol Consumption				Diet				Sleep quality				Physical activity			
		χ^2	df	p	V	χ^2	df	p	V	χ^2	df	p	V	χ^2	df	p	V
Combined	Gender	2.39	4	.332		**23.33**	**4**	**<.001**	**0.291**	**8.54**	**4**	**.037**	**0.176**	6.97	4	.069	
	Child(ren) at home	4.59	4	.166		**10.25**	**4**	**.018**	**0.196**	2.78	4	.298		4.70	4	.159	
	Work status change	5.03	4	.142		5.18	4	.135		7.17	4	0.064		**10.82**	**4**	**.015**	**0.198**
	Vulnerability status	3.93	4	.208		7.27	4	.061		3.35	4	.251		3.14	4	.535	
	Self-isolation status	**8.05**	**4**	**.045**	**0.219**	**18.38**	**4**	**<.001**	**0.259**	7.49	4	.056		7.34	4	.059	
Scotland-only	Gender	2.05	4	0.363		**14.36**	**4**	**.003**	**0.323**	1.88	4	.379		7.29	4	.061	
	Child(ren) at home	**11.13**	**4**	**.013**	**0.329**	**9.60**	**4**	**.024**	**0.264**	3.70	4	.224		3.12	4	.270	
	Work status change	5.20	4	.138		1.37	4	.425		**8.27**	**4**	**<.041**	**0.245**	**9.30**	**4**	**.027**	**0.260**
	Vulnerability status	3.92	4	.208		5.98	4	.105		2.49	4	.324		1.25	4	.436	
	Self-isolation status	3.35	4	.251		7.44	4	.057		2.36	4	.335		4.95	4	.147	
Japan-only	Gender	2.96	3	.199		**7.77**	**4**	**.050**	**0.237**	5.81	3	.061		**6.58**	**3**	**.044**	**0.218**
	Child(ren) at home	5.14	3	.081		2.04	4	.365		4.70	3	.098		1.59	3	.331	
	Work status change	2.11	3	.275		4.37	4	.179		1.78	3	.620		4.24	3	.119	
	Vulnerability status	1.38	3	.356		2.90	4	.288		0.76	3	.430		2.46	3	.242	
	Self-isolation status	3.33	3	.172		1.91	4	.376		**11.49**	**3**	**.005**	**0.288**	2.27	3	.259	

Note. Significant results highlighted in **bold**. V = Cramér's V. Degrees of freedom for Japanese alcohol consumption are smaller as no such participants indicated 'drinking a lot more'. Degrees of freedom for Japanese sleep quality and physical activity are smaller as no such participants chose 'sleep a lot better' or 'a lot more active'.

and follow-up comparisons are identified within the next section.

All data collected in this study are available at [Citation and reference removed to support blind review]

Results

Socio-demographic features and peri-pandemic health behaviours

Pearson's chi-square analyses are summarised in Table 4. Cramér's V was used as a measure of effect size, with interpretations based on Cohen's (1988) standards. Significant associations are expanded upon in the subsequent sub-sections. Participants' clinical vulnerability status was not associated with health behaviours, either in the combined analysis, or individually within the Scottish or Japanese subgroups.

Alcohol consumption (drinkers-only). In the combined analysis, there was a significant medium-sized association between self-isolation status and alcohol consumption behaviours. Those who had self-isolated typically changed their alcohol consumption, whereas those who had not had to isolate generally did not change their alcohol consumption. Within the isolation-experienced group, 35% of participants were drinking more, 40% were drinking about the same, and 26% were drinking less. Among the non-isolating group, only 23% were drinking more, 54% were drinking about the same amount, and 23% drinking less.

We explicitly compared changes in alcohol consumption behaviours based on national group. Two cells (20%) in the contingency table had expected counts <5; therefore, a Fischer's exact test was performed. A significant association between national group and changes in alcohol consumption was observed [p=0.045]. Observed and expected counts are shown in Table 5.

Every participant who reported drinking a lot more was Scottish, and in terms of participants who reported drinking a little more, most were in Scotland, whereas few were in Japan. Of participants reporting no change in their alcohol consumption, most were in Scotland and fewer were in Japan. In terms of those drinking a little less, most were in Scotland and few were in Japan, and of participants who drinking a lot less, most were in Scotland and fewer were in Japan.

In the Scotland-only data, a Fischer's exact test showed that participants with children in their household typically showed increased consumption or stability [p = .027]. Participants with no children in their households demonstrated heterogenous change patterns. This is illustrated in Table 6. Approximately 31% of Scottish participants with children in their home reported drinking more since the pandemic began, 61% reported drinking about the same amount, and only 8% reporting drinking less. Those with no children in the home, however, fell into roughly three equal camps – drinking more (approximately 34%), drinking the same amount (34%), and drinking less (31%). Exploration of changes in Japanese drinkers' consumption behaviours and their personal characteristics revealed no signification associations.

Diet. In the combined analysis, there was a reasonably strong association between participant isolation status and

Table 5. Breakdown of alcohol consumption changes by country group.

Group		A lot more	A little more	About same	A little less	A lot less
Scotland	n (%)	8 (7.8%)	26 (25.2%)	45 (43.7%)	10 (9.7%)	14 (13.6%)
Japan	n (%)	0 (0.0%)	10 (15.6%)	39 (60.9%)	5 (7.8%)	10 (15.6%)

Note. Values represent: n = observed frequency (% within-group). Fischer's exact *p*=0.045.

Table 6. Breakdown of alcohol consumption changes by children-in-household (Scotland-only).

Group		A lot more	A little more	About same	A little less	A lot less
Child(ren)	n (%)	1 (2.8%)	10 (27.8%)	22 (61.1%)	1 (2.8%)	2 (5.6%)
No child(ren)	n (%)	7 (10.4%)	16 (23.9%)	23 (34.3%)	9 (13.4%)	12 (17.9%)

Note. Values represent: n = observed frequency (% within-group). Fischer's exact *p*=0.027.

Table 7. Breakdown of dietary changes across demographic variables.

Group		− −healthy	−Healthy	≈	+ Healthy	+ + healthy
Isolated	n (%)	10 (15.9%)	15 (23.8%)	20 (31.7%)	14 (22.2%)	4 (6.3%)
Non-isolated	n (%)	13 (6.1%)	34 (16.0%)	130 (61.0%)	30 (14.1%)	6 (2.8%)
Males	n (%)	12 (9.2%)	16 (12.3%)	85 (65.4%)	10 (7.7%)	7 (5.4%)
Females	n (%)	11 (7.5%)	34 (23.3%)	64 (43.8%)	34 (23.3%)	3 (2.1%)
Child(ren)	n (%)	7 (8.8%)	23 (28.7%)	37 (46.3%)	12 (15.0%)	1 (1.3%)
No Child(ren)	n (%)	16 (8.1%)	27 (13.7%)	113 (57.4%)	32 (16.2%)	9 (4.6%)
Scotland	n (%)	20 (14.5%)	43 (31.2%)	46 (33.3%)	23 (16.7%)	6 (4.3%)
Japan	n (%)	3 (2.2%)	7 (5.1%)	103 (74.6%)	21 (15.2%)	4 (2.9%)

Note. Values represent: n = observed frequency (% within-group). - - = a lot more (unhealthy change); - = a little more (unhealthy change); ≈ = about the same; + = a little more (healthy change), + + = a lot more (healthy change).

dietary behaviours. This is illustrated in Table 7. Broadly, this was characterised by 'change' in the group who had experienced self-isolation, and stability in those who had not self-isolated.

In the combined analysis, the strong association between participant gender and diet was characterised by stability for males and change for females. This is illustrated in Table 7. Male participant responses indicated that most had maintained their diet. However, female data indicated that most had changed their diet.

The moderate association between having children in the household (or not) and dietary behaviours in the combined analysis was significant and is broken down in Table 7. Those with child(ren)-at-home typically reported unhealthy changes or stability; those who did not live with a child (or children) typically reported no change, with fairly even proportions reporting healthy/unhealthy changes.

A Pearson's chi-square analysis revealed a significant strong association between national group and dietary changes [$\chi^2(4) = 60.78$, $p < .001$, $V = 0.469$]. This is illustrated in Table 7. Of participants reporting that their diet was a lot worse, the vast majority were Scottish; similarly, of those reporting that their diet was a little worse, the vast majority were Scottish. Contrastingly, of participants who were able to maintain their diet, most were Japanese. For those enjoying a healthier diets, the proportions were more balanced.

The Scotland-only data revealed a strong association between gender and diet, and this was again characterised by males typically maintaining their diet, but females reporting change. Data from males in Scotland showed that approximately 35% had a less-healthy diet and 43% had maintained their diet. Data from females-in-Scotland revealed that 46% had a less-healthy diet, only 27% had maintained their diet, and 27% had a healthier diet.

Within the Scotland subgroup, those who co-habited with child(ren) were typically following a less-healthy diet (61%), whereas only 28% had maintained their diet, and only 11% reported enjoying a healthier diet. Of participants in Scotland who did not live with children, 38% had a less-healthy diet, 36% reported no change, and 26% reported enjoying a healthier diet. This was a reasonably strong association.

The reasonably strong association between gender and diet in Japan-based participants' data was defined by

Table 8. Breakdown of perceived sleep quality by national group.

Group		A lot worse	A little worse	About same	A little better	A lot better
Scotland	n (%)	21 (15.2%)	45 (32.6%)	62 (44.9%)	5 (3.6%)	5 (3.6%)
Japan	n (%)	1 (0.7%)	27 (19.4%)	102 (73.4%)	9 (6.5%)	0 (0.0%)

Note. Values represent: n = observed frequency (% within-group). [$\chi^2(4)$=38.66, p<0.001, V=0.372].

stability in males and (typically positive) change in females. Of males in Japan, 82% had not changed their diet; data from females-in-Japan data showed that 66% had maintained their diet, and 24% had adopted a healthier diet.

Perceived sleep quality. The overall association between gender and sleep quality appeared to be determined by greater stability of sleep quality among men than women; this was a medium-sized effect. Among men, 28% reported lower sleep quality, 68% reported no perceived change, and 5% reported enjoying better-quality sleep. Of women, 40% reported poorer sleep quality, 51% reported no change, and 9% reported improved sleep quality.

A Pearson's chi-square analysis revealed a significant, strong association between national group and perceived changes in sleep quality [$\chi^2(4) = 38.66, p < .001, V = 0.372$]. This is illustrated in Table 8.

Of participants reporting that their sleep was worse, the vast majority were based in Scotland. Contrastingly, of participants who reported that their sleep quality was unchanged, the majority were in Japan. For those who reported sleeping better, most were in Japan.

Within the Scotland sample, there was a moderate-to-strong association between changes in work status and perceived sleep quality. Of those who reported that their working status had changed, 54% reported poor perceived sleep quality, 43% reported no change, and only 3% reported improved sleep quality. However, 49% of those whose work status remained unchanged reported poorer sleep quality, 46% reported no change, and 9% reported improved sleep quality.

Within Japanese participants' data, there was a reasonably strong association between perceived sleep quality and isolation status. Of those who had to self-isolate, 25% reported poorer sleep quality, and no participants reported better perceived sleep quality. Among non-isolators, only 20% reported sleeping more poorly, and 7% reported better-quality sleep.

Physical activity. In the combined analysis, there was a moderate-to-strong association between changes in work status and changes in physical activity levels. This is broken down in Table 9.

As anticipated, for those whose work status had changed, the majority of participants were less active. For those whose work status had not changed, although most were

also less active, a greater proportion of this group had been able to maintain or improve their activity levels compared to participants whose work status had changed. This association was also significant in the subset of data gathered from Scotland (and indeed, was associated with a large effect size). Of those participants whose work status had changed, 60% were less active, 9% reported no change, and 31% were more active. Of Scotland-based participants whose work status was unchanged, 53% were less active, 27% reported no change, and 20% were more active.

A Pearson's chi-square analysis revealed a significant strong association between national group and changes in physical activity [$\chi^2(4) = 35.76, p < .001, V = 0.360$]. This is broken down in Table 9. The participants who reported being a little less active were predominantly based in Japan. The vast majority of participants who reported being a more active, however, were based in Scotland.

Amongst Japan-based participants, there was a moderate association between participant sex and changes in physical activity levels. This was characterised by relative stability in males' activity levels, and general reductions in females' activity levels.

Relationships between health behaviours

Results are summarised in Table 10

Combined analyses revealed a small positive relationship between changes in alcohol consumption and dietary changes. Combined analyses revealed significant positive inter-relationships between changes in diet and sleep quality, dietary changes and changes in physical activity levels, and physical activity changes and changes in sleep quality.

Scotland-based participants' data broadly reflected this overall pattern; the relationship between changes in alcohol consumption and diet did not reach significance ($p = .052$). The relationship between changes in diet and changes in physical activity levels were strong in the Scotland-based sample data.

Japan-based participants' data revealed a slightly different pattern; first, there was a small-to-moderate negative relationship between changes in alcohol consumption and changes in physical activity. Exploration of this pattern revealed that the negative correlation may reflect a sub-cohort of participants who were drinking a little/a lot less, who were also a lot/a little less active; and another sub-cohort who were a little more active but who did not alter

Table 9. Breakdown of physical activity changes across demographic variables.

Group		A lot less	A little less	About same	A little more	A lot more
Work change	n (%)	21 (32.8%)	27 (42.2%)	5 (7.8%)	6 (9.4%)	5 (7.8%)
No change	n (%)	64 (30.2%)	74 (34.9%)	50 (23.6%)	19 (9.0%)	5 (2.4%)
Scotland	n (%)	41 (29.7%)	34 (24.6%)	31 (22.5%)	22 (15.9%)	10 (7.2%)
Japan	n (%)	45 (32.6%)	66 (47.8%)	24 (17.4%)	3 (2.2%)	0 (0.0%)

Note. Values represent: n = observed frequency (% within-group).

Table 10. Relationships between changes in health behaviours.

		df/n	Diet	Sleep	Activity
Combined	Alcohol consumption	167	**0.181****	−0.037	−0.012
	Diet	277	—	**−0.321****	**−0.230****
	Sleep	277		—	**−0.156****
	Physical activity	277			—
Scotland-only	Alcohol consumption	103	0.161	−0.075	−0.128
	Diet	138	—	**−0.352****	**−0.400****
	Sleep	138		—	**−0.188***
	Physical activity	138			—
Japan-only	Alcohol consumption	164	0.147	−0.058	**−0.219***
	Diet	139	—	−0.075	−0.115
	Sleep	139		—	**−0.294****
	Physical activity	139			—

Note. Positive relationships indicate that 'healthier' changes in one dimension are associated with 'healthier' changes in the other. *$p<0.05$, **$p<0.01$.

their drinking behaviours. In contrast to the global and Scottish-context data, there was no relationship between dietary changes and sleep quality, and the relationship between diet and physical activity did not reach significance.

Health behaviours and negative mood scores

The following section includes a comparison of NMS based on participants' health behaviours. Data was pre-screened to identify outliers via boxplots, and to consider normality of distribution via Q-Q plots. Assumptions were met. Unless otherwise stated Levene's Test of Equality of Error Variances produced a satisfactory (i.e., non-significant, >0.05) result. Due to uneven cell sizes and/or small numbers of participants in certain cells, this analysis is presented on combined data only, rather than subdivided by, for example, national identity group. All analyses represent one-way between-subjects' analyses of variance (ANOVAs), and where appropriate, follow-up comparisons are presented with Bonferroni corrections.

Alcohol. There were no significant differences in participants' NMS based on changes in alcohol consumption [$F(4,161) = 1.39$, $p = .240$].

Diet. There were no significant differences in participants' NMS based on dietary changes[$F(4,271) = 2.23$, $p = .066$].

Sleep quality. A small, significant difference in participants' mood scores based on perceived changes in sleep quality was found [$F(4,271) = 4.97$, $p = .001$, $\eta_p^2 = .068$]. Descriptive statistics are illustrated in Figure 1.

Follow-up comparisons revealed that the only significant difference ($p = .001$) lay between the mean NMS of those whose sleep was a little worse (366) and those whose sleep quality was perceived as the same (250). However, as can be seen in Figure 1, the scores within-groups are highly variable.

Physical activity. A small, significant difference in participants' mood scores based on physical activity levels was found [$F(4,271) = 3.50$, $p = .008$, $\eta_p^2 = 0.049$]. Descriptive statistics are illustrated in Figure 1. Follow-up comparisons revealed that the only significant difference ($p = .036$) lay between the mean negative mood scores of those who were a lot less physically active (351) and those whose activity level did not change (246). However, as can be seen in Figure 1, the scores within-groups are highly variable.

Health behaviours and perceived isolation

The following section includes a comparison of perceived isolation based on participants' health behaviours. Data were pre-screened in the same manner as NMS. As before, due to uneven cells sizes and/or small numbers of
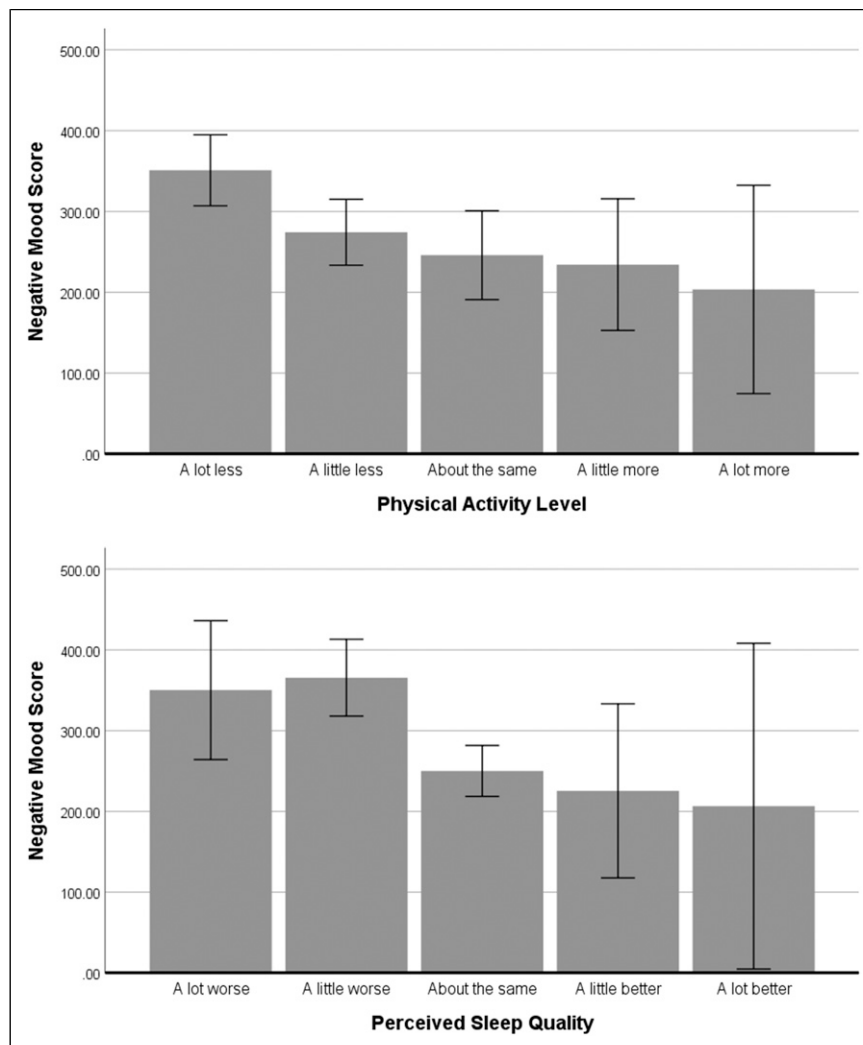
Figure 1. Negative Mood Scores by changes in Physical Activity Level (upper) and Perceived Sleep Quality (lower). Error bars represent 95% confidence intervals.

observations, this data is not subdivided on cross-sectional factors. Again, these findings represent the results of one-way between-subjects ANOVAs.

Alcohol. A small, significant difference in participants' perceived social isolation based on alcohol consumption was found [$F(4,161) = 3.67$, $p = .007$, $\eta_p^2 = .083$]. Descriptive statistics are illustrated in Figure 2.

Follow-up comparisons revealed that participants who reported drinking a lot more reported feeling more isolated (79) than both those drinking a little more (45, $p = 0.014$) and those whose drinking remained unchanged (50, $p = .036$). No other comparisons were significant.

Diet. Analysis revealed a small significant difference in participants' perceived social isolation based on of dietary changes [$F(4,271) = 2.70$, $p = .031$, $\eta_p^2 = 0.038$]. Descriptive statistics are illustrated in Figure 2. However, none of the follow-up comparisons reached statistical significance (all ps>0.170).

Sleep quality. Analysis revealed a small significant difference in participants' perceived social isolation based on perceived changes in sleep quality [$F(4,271) = 4.58$, $p = .001$, $\eta_p^2 = 0.063$]. Descriptive statistics are illustrated in Figure 2. Follow-up comparisons revealed that participants who perceived that their sleep had remained unchanged had lower perceived isolation (49) than both participants who reported their sleep being a little worse (61, $p = .022$) and those who reported their sleep to be a lot worse (68, $p = .016$). All other comparisons were non-significant; however, it is worth noting that the inter-group range of isolation scores of participants with 'much better sleep quality' is high.
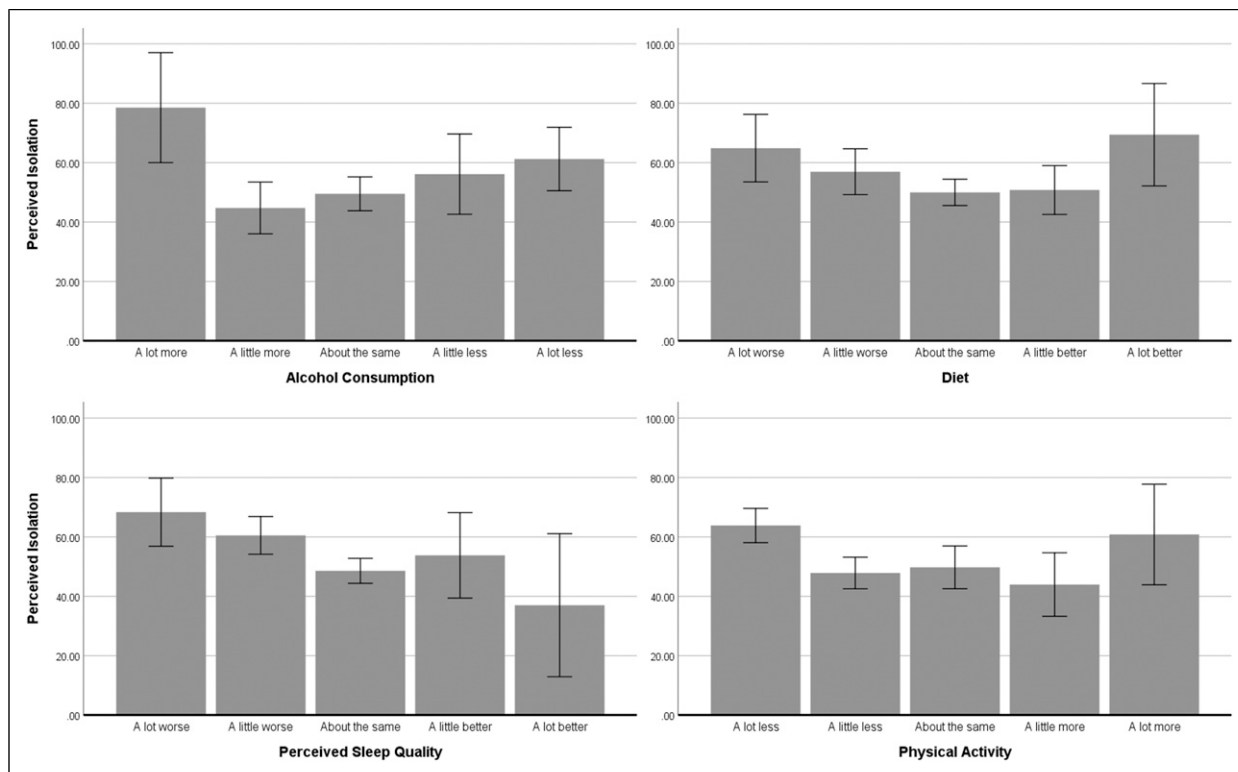
Figure 2. Perceived Isolation scores across changes in health behaviours. Error bars represent 95% confidence intervals.

Physical activity. Analysis of all participants' data revealed a small, significant difference in participants' perceived social isolation based on changes in physical activity levels [$F(4,271)=5.40$, $p < .001$, $\eta_p^2 = 0.074$]. Descriptive statistics are illustrated in Figure 2. Follow-up comparisons revealed that the significant differences lay between those who were a lot less active (64) and three other groups (that did not differ from one another): those who were a little less active (48, $p = .001$), those whose activity remained unchanged (50, $p = .030$), and those who were a little more active (44, $p = .015$).

Transnational comparisons – negative mood and isolation

A Levene's test of equality of error variances revealed a non-significant result ($p = .670$). A one-way ANOVA revealed that Japanese participants had, on average, greater negative mood than Scottish participants [312 vs. 260; $F(1,274) = 4.19$, $p = .042$, $\eta_p^2 = 0.015$].

In terms of perceived isolation, a Levene's test of equality of error variances revealed a non-significant result ($p = .124$). A one-way ANOVA revealed no significant difference between Japanese and Scottish participants' perceived isolation [$F(1,275) = 2.63$, $p = .106$].

Negative mood, isolation, and age

Pearson's correlational analyses revealed a significant and moderately strong relationship between negative mood scores and perceived social isolation [$r(276) = 0.381$, $p < .001$, one-tailed]. Analysis revealed significant negative relationships between participant age and NMS [$r(276) = -0.120$, $p = .023$, one-tailed] and age and perceived isolation ratings [$r(277) = -0.128$, $p = .017$, one-tailed]; thus, it is suggested that younger participants were in a worse mood and felt more isolated than older participants.

Transnational comparisons – preventative measures

Participants were given an open-field response opportunity to explain which (if any) prophylactic measures they were taking during their pandemic. Japanese-language responses were translated using Google Translate (https://translate.google.co.uk/). Responses were generally one-word answers or short phrases which listed the preventative measures taken. All participants (bar 1 Scotland-based participant) provided data. One member of the research team read through all participant responses multiple times to identify codes which were then amalgamated into the categories/themes presented in Table 5. A set of eight frequently mentioned behaviours were identified. Neither

Table 11. Percentage of respondents engaging in preventative behaviours.

	Mask-wearing	Hand-washing	Hand-sanitising	Avoiding others	Gargling	Staying home	Extra bathing	Social distancing
Scotland	55%	46%	25%	62%	0%	73%	0%	83%
Japan	68%	61%	22%	15%	24%	25%	4%	9%

the exact frequency of completing the behaviour nor intensity of the behaviour was assessed/quantified. These are summarised in Table 11.

A greater proportion of participants in Japan explicitly mentioned mask-wearing than those participants in Scotland. Similarly, a greater proportion of Japan-based than Scotland-based participants explicitly reported augmenting their hand-hygiene and hand-washing. Hand sanitisation with alcohol or other substances was mentioned by approximately the same proportion of participants across national contexts. Avoiding others was mentioned by a far greater proportion of Scotland-based participants than Japan-based participants; furthermore, linguistically, participants in Scotland tended to mention family, friends, partners when describing their 'avoidance', whereas participants in Japan tended to only mention avoiding crowds/strangers. Almost a quarter of participants in Japan referred to 'gargling' (i.e., the use of antiseptic mouthwash), whereas this behaviour was not cited by participants in Scotland. A far greater proportion of participants in Scotland explicitly mentioned staying at home (except for all but non-essential purposes, typically grocery shopping and individual exercise) than Japan-based participants. Extra bathing/increased bodily hygiene measures were mentioned by a small proportion of Japan-based participants (particularly after these individuals had been outside of their homes); however, this behaviour was not cited by participants in Scotland. Finally, a far greater proportion of Scotland-based than Japan-based participants reported 'social distancing' away from others outside their households.

Holistically, participants from Scotland tended to engage in a greater number of prophylactic measures per person (Mo = 3; various), than Japanese participants (Mo = 1; mask-wearing only).

Discussion

This study examined associations between socio-demographic factors, COVID-19 induced changes to health behaviours, and negative mood and isolation. Transnationally, we compared two different forms of lockdown: a highly restrictive and legally enforced lockdown within Scotland and a less obtrusive, requested, mild lockdown in Japan. In both countries, we found that lifestyle restrictions impacted upon health behaviours and wellbeing, and support previous findings (e.g., Ingram et al., 2020) via

a different participant sample and timepoint within the COVID-19 pandemic.

Increased alcohol consumption is frequently linked to poorer mental health (Alford et al., 2020; Birnbaum et al., 1983; Howland et al., 2010; Parker et al., 1987), although, in a study completed during COVID-19 lockdown in May 2020 (Ingram et al., 2020), no significant associations were found between changes in alcohol consumption and negative mood. That pattern is reflected in the current study; however, we found an association between perceived isolation and changes in alcohol. Loneliness has been previously linked to alcohol abuse (Schonfeld and Dupree 1991), but not with alcohol use in persons who consume within acceptable guidelines (Canham et al., 2016). However, lockdown induced feelings of isolation are not directly comparable with psychological loneliness. Having to self-isolate was associated with increased alcohol consumption in the combined analysis; it is possible that self-isolating participants (37% of Scotland-based and 8.6% of Japan-based respondents) have driven the association between perceived social isolation and increased consumption of alcohol. In an international study Saille et al. (2020) found an overall reduction in alcohol intake during quarantine. However certain subgroups were found to have increased consumption, and this included individuals caring for children similar to the findings of Ingram et al. (2020). Saille et al. also considered the data at country level and found that within the UK alcohol consumption did increase during quarantine, these results reflect those of the participants in Scotland within the current study.

Across countries, patterns of changes in alcohol consumption differed. Participants in Scotland had increased their drinking during the pandemic more so than those in Japan. Increases were linked to having children in the home, as previously seen in Ingram et al. (2020). At the time of data collection, education and childcare in Scotland were closed to all but essential workers, while these remained open in Japan. Lockdown has been shown to be particularly stressful for individuals who needed to balance work and childcare (e.g., Spinelli et al., 2020); therefore, increases in alcohol consumption may be linked to additional stress. However, such increases are particularly troubling given the evidence that exposure to parental/caregiver drinking can influence future alcohol consumption (Grazioli et al. 2015; Smit et al. 2020), and such increases have already been highlighted as a dangerous consequence of the pandemic

(Sigman 2020). Highlighting more-clearly to those living with children the potential impact of these behaviours should be prioritised if future lockdowns are needed.

The null finding regarding mood and dietary changes contrasts with previous research which found that unhealthier diets tended to be linked to poorer mental well-being during the pandemic (Amatori et al., 2020; Ingram et al., 2020; Yamamoto et al., 2020). As participants had spent nearly 11 months with at least some pandemic-related restrictions in place it is possible that associations between wellbeing and diet were less-pronounced. Fewer changes to diet in participants from Japan may reflect the milder style of lockdown. As the day-to-day routine changed less, people were less likely to fall into poorer eating habits (or indeed develop healthier eating strategies). Globally, females were more likely to adopt a less-healthy diet during the pandemic, but this difference was more pronounced in Scotland. Adults living with a child (or children) in Scotland were more likely to have adopted an unhealthier diet than those who did not share their households in this way. As with alcohol this may reflect the more restrictive nature of the lockdowns in terms of childcare, with those losing their external support mechanisms eating more unhealthily due to stress or time constraints (e.g., Escoto et al., 2012).

Poorer mental health has been linked with sleep problems throughout the COVID-19 pandemic (Cellini et al., 2020; Yurteri and Sarigedik 2021), in both countries of interest (Ingram et al., 2020; Yamamoto et al., 2020). Country, gender, change in work-status (Scotland) and self-isolation (Japan) were all associated with poorer sleep quality. Suffering stressful life events during the pandemic associated with poorer sleep quality, as would be expected (Sandford et al. 2014). Our results suggest that the milder lockdown conditions imposed in Japan were less disruptive to sleep patterns and consequently less disruptive to wellbeing.

As expected, an association was found between measures of mental wellbeing and physical activity, with negative changes to physical activity levels linked to poorer wellbeing. Similar links have been reported in other COVID-19 research and particularly in the countries of interest (Ingram et al., 2020; Kamyuka et al., 2020; Koohsari et al., 2021; Makizako et al., 2021; Yamada et al., 2020). Our data does not consider causation and so it may be that experiencing greater negative mood and feelings of social isolation are associated with participants changing their physical activity levels (Robbins et al., 2018; Werneck et al., 2019), or that shifts to lower levels of physical activity have affected mental wellbeing (Cerin et al., 2009). However, given that changes to work-status were associated with less physical activity, it is possible that this change may be influenced by mental wellbeing in this group. In contrast to other health behaviours, participants from Japan were more likely to report negative changes in physical activity although our data do not reveal any underlying reason for this change.

Comparing preventative measures taken in response to the pandemic revealed interesting differences which likely reflect the styles of lockdown. Participants in Japan focused on personal hygiene and mask-wearing, whereas participants in Scotland focused more on avoidance of people and remaining within the home. It is common in Japan to combat infection with regular hand-washing and gargling, which has been demonstrated to be effective in reducing incidence of upper respiratory tract infections (e.g., Satomura et al., 2005). Early health advice in both countries strongly advised frequently washing and/or sanitising hands; however, after acknowledgement that transmission of the virus may be airborne (Morawska and Milton 2020), further information on avoiding crowds and remaining ≥ 2 m from other people was emphasised, and such activities seem to be the focus of respondents in Scotland. The mild nature of the lockdown in Japan has made avoiding crowds and keeping distance virtually impossible in some areas where large numbers of commuters are still travelling to work.

Taken together, the different styles of lockdown (strict vs mild) are associated with apparent differences in relation to health behaviours. During the more restrictive lockdown in Scotland there was greater change, often negative, to health behaviours. This was likely due to greater disruption to lifestyle. Whilst it is necessary to combat the immediate threat of COVID-19, future restrictions may be weighed against the potential long-term negative effects on health behaviours. Particularly in situations where restrictions lead to highly stressful situations, such as changes to working life or childcare arrangements. Negative changes to health behaviours were typically associated with poorer mental wellbeing, as seen in previous studies during the pandemic (e.g., Ingram et al., 2020; Ozamiz-Etxebarria et al., 2020). However, not all change was negative. Whilst participants in Japan were overall more likely to maintain their pre-pandemic health behaviours, some participants in Scotland had made healthy changes over the course of the pandemic. This is consistent with previous research demonstrating unexpected positive outcomes of lockdown (Cornell et al., 2021; Williams et al., 2021). Further research may focus on situational and personal factors which contribute to positive change under these circumstances, such as local/national campaigns highlighting the benefits of more family time or homeworking.

There are several limitations to the current study. Participants' health behaviours were only sampled at a single timepoint, hence it is difficult to draw conclusions in relation to the cause-and-effect relationships between restrictions, health behaviours and mental health. Furthermore, we did not gather information about the COVID-19 infection status of participants from both groups due to cultural sensitivities within Japan. Our conclusions are therefore limited as COVID-19 infection may itself be

linked to poorer health behaviours and wellbeing. Our sample size is relatively small and the mode of sampling, using an internet-based survey on participant recruitment websites, is likely to have biased the range of respondents ruling out most older adults, people with low technological literacy, and possibly those with low socio-economic status. In Scotland the mean age of participants was slightly lower than the national average (39.3 vs. 40 years) and our sample was skewed towards female participants (59% vs. 52% female; https://www.scotlandscensus.gov.uk/). Our participants from Japan were also younger than average (39.3 vs 48 years) and our sample had a higher proportion of male participants than in the population (53% vs. 48%; https://population.un.org/wpp/) There are also additional factors, beyond the scope of the current article, which may have had an impact on health behaviours and wellbeing in Japan and Scotland - for example, fear of COVID-19 infection and cultural differences between participants.

Conclusions

In line with our initial predictions, those who had experienced greater restriction (e.g., self-isolation) and those who had experienced greater change (e.g., change to working circumstances) demonstrated more negative changes in health behaviours. These negative changes were particularly prominent within participants from Scotland. We anticipated that those who reported negative changes to health behaviours would also experience greater negative mood. Our data supports this prediction with regards to quality of sleep and level of physical activity but not in relation to alcohol consumption or dietary changes. We conclude by noting the importance of maintaining or making small improvements to health behaviours during COVID-19 lockdown. Such advice at times of stress is not novel; however, lockdown situations may be treated as exceptional, with those under stress less likely to follow guidelines. Public health bodies should also focus on non-disease health factors during times of lockdown - particularly, encouraging good sleep habits and increasing physical activity. Such behaviours may be both more-beneficial to wellbeing and more readily adoptable than improving diet or reducing alcohol intake.

Authors Contributions

JI, CJH, YH, and GM designed the research; JI acquired funding and administered the project; JI, YH, and GM developed materials and collected data; GM completed data pre-processing; GM and CJH conducted data analysis. All authors contributed to the drafting and editing of the paper.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval

Ethical approval was given by the School of Education and Social Science Ethics Committee at the University of the West of Scotland, and the Faculty of Humanities and Social Sciences Ethics Committee at the University of Tsukuba.

Consent to Participate

All participants provided informed consent to participate.

Data availability

The data that support the findings of this study are available in Open Science Framework at https://osf.io/qsbuk/

Code availability

All data have been analysed using standard software and procedures.

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Notes

1. Specific details of the lockdown conditions within each country, historically and at the point of data collection, are detailed within the Method.
2. With the exception of outdoor exercise which became unrestricted on 11th May 2020.

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