Current Psychology (2023) 42:20804–20813
https://doi.org/10.1007/s12144-022-03183-y

Impact of restrictive COVID-19 measures on daily momentary affect in an epidemiological youth sample in Hong Kong: An experience sampling study

Stephanie M. Y. Wong[1] · Yandy Y. Li[1] · Christy L. M. Hui[1] · Corine S. M. Wong[1] · T. Y. Wong[1] · Charlton Cheung[1] · Y. N. Suen[1] · Bess Y. H. Lam[1] · Simon S. Y. Lui[1] · K. T. Chan[1] · Michael T. H. Wong[1] · Sherry K. W. Chan[1,2] · W. C. Chang[1,2] · Edwin H. M. Lee[1] · Inez Myin-Germeys[3] · Eric Y. H. Chen[1,2]

Accepted: 2 May 2022 / Published online: 17 May 2022

Abstract

Restrictive COVID-19 measures can have significant mental health impacts, particularly on young people. How such measures may influence day-to-day momentary affect, nonetheless, remains to be explored. Experience sampling data were collected from 165 young people (aged 15–24) as part of a larger epidemiological youth mental health study in Hong Kong. We examined the impact of one of the most stringent COVID-19 measures – dine-in restrictions – on momentary positive and negative affect and current contexts and activities of these young people. The effects of a milder form of COVID-19 measure – school suspension – were separately examined. Multilevel analysis revealed that those in the dine-in ban group, compared to dining-as-usual, showed significantly reduced momentary positive affect ($\beta = -0.17$, $SE = 0.06$, $p = 0.003$). Its effect remained significant even when accounting for baseline depressive and anxiety symptoms and socioeconomic status ($\beta = -0.15$, $SE = 0.05$, $p = 0.008$). The effect of dine-in ban on reduced momentary positive affect was found specifically when participants were in indoor locations (e.g., home, office), alone, and engaged in passive leisure activities. This pattern was not observed when participants were at school or at other outdoor locations, with friends, or engaged in active leisure activities. No significant effect of school suspension on momentary affect was observed. More severe COVID-19 measures, such as dine-in ban, can have significant impacts on the momentary positive affect of young people. Certain contexts and activities may offer protection against the consequences of COVID-19 measures. The current findings may help to inform future designs of mental health interventions and public health policies.

Keywords COVID-19 · Experience sampling method · Momentary positive affect · Youth mental health

Background

Coronavirus disease 2019 (COVID-19) is among the most recent public health crises faced by the global community. Apart from its physical health consequences, studies have reported significant mental health impacts associated with the pandemic across societies, including heightened symptoms of depression, anxiety, and post-traumatic stress disorder, as well as suicidal ideation and behaviours, particularly in young people (Czeisler et al., 2021; Thorisdottir et al., 2021; Wong et al., 2021a, b; in press). COVID-19 symptoms have also been reported to be associated with poorer mental health outcomes (Taquet et al., 2021; Wang et al., 2021). How momentary affective mood states may be influenced by COVID-19 across contexts, however, remains to be investigated in representative samples of young people.

Stephanie M. Y. Wong and Yandy Y. Li contributed equally to this work.

✉ Eric Y. H. Chen
eyhchen.hk@gmail.com

[1] Department of Psychiatry, School of Clinical Medicine, LKS Faculty of Medicine, The University of Hong Kong, 2/F New Clinical Building, Queen Mary Hospital, Pokfulam Road, Hong Kong, China

[2] The State Key Laboratory of Brain and Cognitive Sciences, The University of Hong Kong, Hong Kong, China

[3] Department of Neurosciences, Research Group Psychiatry, Center for Contextual Psychiatry, KU Leuven, Leuven, Belgium

While public health policies and measures are necessary to contain the spread of COVID-19, their impacts on daily routines and lifestyles can possibly be deleterious to mental health (Kämpfen et al., 2020; van de Groep et al., 2020). The different precautionary, social distancing, and lockdown measures adopted for addressing varying levels of pandemic threats across societies could also have different effects on the population (e.g., Hao et al., 2020; Le et al., 2020; Tran et al., 2020; Wang et al., 2020). For instance, especially in societies where household space is limited, such as Hong Kong, dining out may be a regular practice and serves important social and familial functions. Large-scale dining restrictions could as such have disproportionate impacts on the mental health of these populations.

As one of the first cities affected by the pandemic, Hong Kong has already undergone multiple waves of COVID-19 and phases of lockdown since early January 2020 (Chu et al., 2021). With the prior experience of the severe acute respiratory syndrome (SARS) in 2003, safety measures were quickly adopted by the population, such as the use of surgical masks and other personal protective equipment (Wan et al., 2020). To contain the spread of COVID-19 in the city, various social distancing measures have been implemented by the local government across different periods (see Supplementary Material S1 for a summarised timeline). Some examples included the compulsory wearing of face masks in public, group gathering limits in public, special work arrangements, and closure of leisure and entertainment premises (e.g., fitness centres, beauty parlours, amusement game centres). Of specific relevance to students, school suspension has also been put into effect over several periods (25 January to 26 May 2020, 13 July to 22 September 2020, 2 December 2020 to 5 February 2021) (see Supplementary Material S2 and Table S1 for further details).

Among the various measures, one of the most costly COVID-19 measures that affected the entire population was the city-wide "dine-in ban" in addition to the other less restrictive measures, where restaurant dine-in services throughout the city were prohibited at specified times. In densely populated cities like Hong Kong, dining in restaurants is a regular activity and one of the most common means of socialisation. Not only so, the practice is also crucial for the sustaining of local businesses in the community (Census and Statistics Department, 2021; Lau et al., 2021). The unpopularity of this specific measure and its impact on the city's social life, business performance, and unemployment have also been documented (Cheng, 2020; Office of the Government Economist, 2021; Yau, 2022). The decision to ban dine-in services thus reflected the severity of concerns over COVID-19 in the city.

While some studies have shown the influences of COVID-19 lockdowns on the mental health of young people, most have been conducted on convenient student samples or through online surveys (Choi et al., 2020; Vindegaard & Benros, 2020). These studies have also predominantly relied on retrospective questionnaires, which may introduce possible bias (e.g., recency effect, recall bias; Trull & Ebner-Priemer, 2009). An examination into how momentary affective states, such as positive and negative affect, of young people could be affected by COVID-19 lockdown measures can be important for the design of more targeted mental health interventions and future population health policies. Compared to typical retrospective reports, the experience sampling method (ESM) provides a robust means to capture real-time stress reactions in response to real-world events (Myin-Germeys et al., 2018; Trull & Ebner-Priemer, 2009). We therefore conducted an ESM study to examine the effects of the most austere COVID-19 measure to date in Hong Kong, i.e., the dine-in ban, on momentary positive and negative affect in a population-representative sample of young people.

We hypothesised that, compared to dining-as-usual, dine-in ban would be associated with lower levels of positive affect and increased negative affect. This effect was expected even after accounting for depressive and anxiety symptoms at baseline, as well as socioeconomic status, and across different physical and social contexts and activities. Meanwhile, these patterns of associations were expected to be less prominent under relatively milder COVID-19 measures, such as school suspension.

Methods

Participants

Participants were consecutively recruited from the ongoing Hong Kong Youth Epidemiological Study of Mental Health (HK-YES), which is a territory-wide, household-based epidemiological study of mental disorders in young people (15–24 years) in Hong Kong. To ensure representativeness of the general youth population, the HK-YES adopts a multistage cluster sampling design based on randomly selected household addresses stratified by geographic location and type of housing quarters as in previous large-scale epidemiological studies. Data in the HK-YES were collected through face-to-face interviews or online video interviews following the same procedures during COVID-19. After excluding the summer school holiday period, 195 young people recruited between 3 December 2019 and 5 February 2021 participated in the current study. To ensure the quality of ESM data, participants with a compliance rate of less than 30% ($n = 30$) were excluded. The current analysis thus consisted of 165 young people.

As the official dine-in ban was first implemented on 15 July 2020 and continued beyond the end of data collection of this study, those who completed the ESM before this date

were classified into the "dining-as-usual" group and those who joined the study on and after 15 July 2020 were classified into the "dine-in ban" group. Those who participated in the study both before and during this period were classified into either of the groups based on the majority of their completed ESM responses (>50%), with their responses collected during the other period excluded from the analyses.

Ethical approval was obtained from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster. Written informed consent was obtained from all participants, with parental or guardian consent sought for participants under 18 years of age.

ESM Procedures

Participants were first given a briefing about the ESM study by trained research staff. Those who provided consent to the study were given a smartphone (Nokia 6.1) pre-installed with "mobileQ" (https://mobileq.org) for the daily ESM assessments (Meers et al., 2020). For six consecutive days, participants were sent 10 prompts (electronic signal beeps) at random time points every day within a 12-hour period (set according to the waking and sleeping times of participants, with 60 minutes as the minimum interval between each beep). Each ESM session takes approximately two minutes to complete and expires 90 seconds after the prompt had no activity been recorded. A trial session was provided to all participants before the ESM period.

ESM Measures

Momentary Affect

Momentary affective states were assessed using five positive affect items (i.e., "I feel cheerful/satisfied/relaxed/hopeful/excited") and five negative affect items (i.e., "I feel irritated/anxious/lonely/afraid/sad"), with each rated on a 7-point Likert scale from 1 (not at all) to 7 (very much).

Physical Context

Current physical environment of the participants was assessed using the item "*Where are you now?*". Eight response options were provided, including core family's home, extended family's home, friend's home, school, office, public transport/on a bike/in a car, other indoor locations, and other outdoor locations. "Core family's home" and "extended family's home" were grouped into "core and extended family" in this study.

Social Context

Current social environment of participants was assessed using the item "*Who is with me?*". Seven options were provided, including core family, extended family, friends, classmates/colleagues, teachers/supervisors, strangers, and nobody (alone). Core and extended family were similarly grouped in this study.

Current Activity

Current activity was assessed using the item "*What are you doing now?*". Response options included active leisure activities (e.g., exercising, going out), passive leisure activities (e.g., using the phone, playing games, watching TV, reading/chatting, watching TV/reading), in class/at work, daydreaming, going somewhere, eating/drinking, self-care (e.g., in the shower, brushing teeth, dressing), household chores, and other activities.

Baseline Measures

Depressive and anxiety symptoms at baseline were assessed using the depression and anxiety subscales (DASS-D and DASS-A, respectively) of the 21-item Depression, Anxiety and Stress Scales (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 and its subscales have been widely adopted in both local and overseas studies during COVID-19 among youth populations (e.g., Rodríguez-Hidalgo et al., 2020; Wong et al., 2021d). Both subscales have also been validated in Chinese youth samples (Wang et al., 2016).

Demographic information, including age, gender, years of education, and socioeconomic status (SES), was also collected. Participants were categorised into the low SES group (vs high SES group) upon meeting any of the following criteria: (i) receiving any form of government subsidy, (ii) family income below the poverty line of Hong Kong set in 2020 (for students), and (iii) family or personal income below the poverty line (for non-students).

Statistical Analysis

All analyses were performed using SPSS version 26.0 and *R* version 4.0.4. Statistical significance was set at the $p < 0.05$ level. Descriptive statistics were computed for all variables. Demographic characteristics were first compared between the dine-in ban and dining-as-usual groups using independent samples *t*-test (for continuous variables) and Chi-square tests (for categorical variables). Differences in the proportions of current physical context, social context, and activity reported in the ESM were compared, with Bonferroni

correction applied to account for multiple comparisons (alpha = 0.05/22 = 0.002).

Since ESM data have a hierarchical structure in which multiple observations are nested within participants, multilevel analysis models were applied to examine the influence of lockdown measures on momentary affect. Age, gender, years of education, and beep number and its interaction with dine-in ban were included in all multilevel analyses. For the multilevel model where dine-in ban was found to be a significant factor for momentary affect, an additional multilevel analysis was applied to account for baseline depressive symptoms (DASS-D) and anxiety symptoms (DASS-A), which may be associated with momentary affect, as well as SES, which may contribute to the availability of coping strategies and resources during COVID-19 and potentially influence momentary affect. Post-hoc analyses were then further performed to examine whether the impact of dine-in ban would be specific to certain physical and social contexts and activities, after accounting for age, gender, years of education, and the effects of time. The *p*-values in all post-hoc analyses were adjusted for multiple testing using the Holm–Bonferroni method. The same set of analyses was applied to test the potential effects of school suspension as a milder form of COVID-19 lockdown.

Results

Sample Characteristics

Sixty-two per cent of the participants ($n = 102$) were female and 70.9% ($n = 117$) were aged 19–24 years, with a mean age of 20.2 (SD = 2.65). The average years of education of the sample was 13.8 (SD = 2.30), with the majority (80.0%; $n = 132$) being students. Ten participants (6.1%) reported having a psychiatric history. The overall mean levels of momentary positive and negative affect assessed through the ESM were 3.12 (SD = 1.56) and 1.71 (SD = 1.00), respectively.

A total of 83 participants were classified into the dine-in ban group and 82 were classified into the dining-as-usual group. No significant group difference was observed in their age, gender, psychiatric history, years of education, student status, SES, and both baseline depressive and anxiety symptoms (all $p > 0.05$) (Table 1). Similarly, no significant difference was observed in any of the demographic characteristics and symptom levels between the school suspension and school-as-usual groups ($p > 0.05$) (Supplementary Material Table S2).

Current Context and Activity

Table 2 presents the event counts and proportions of current physical context, social context, and activity reported. Compared to the dining-as-usual group (3952 momentary responses), participants in the dine-in ban group (3651 momentary responses) were more likely to be at family's home, in school, or alone, and less likely to be in other indoor locations, with strangers, or engaged in self-care activities (all significant at the Bonferroni-corrected cut-off of $p = 0.002$).

Effects of COVID-19 Dine-in Ban as an Austere Form of Pandemic Lockdown

Findings from the first multilevel model revealed that, compared to the dining-as-usual group, those in the dine-in ban group showed significantly lower levels of momentary

Table 1 Descriptive characteristics of the epidemiological youth sample between the dine-in ban and dining-as-usual groups ($n = 165$)

	Dine-in ban group ($n = 83$)	Dining-as-usual group ($n = 82$)	*p*
Age	20.0 (2.59)	20.3 (2.71)	0.48
Gender, n (%)			0.46
Male	34 (41.0)	29 (35.4)	
Female	49 (59.0)	53 (64.6)	
Has psychiatric history, n (%)	7 (8.4)	3 (3.7)	0.20
Years of education	13.69 (2.19)	13.92 (2.42)	0.52
Currently in education, n (%)	68 (81.9)	64 (78.0)	0.53
Socioeconomic status (SES), n (%)			0.27
Low SES	20 (24.1)	14 (17.1)	
High SES	63 (75.9)	68 (82.9)	
Baseline psychiatric symptoms			
Depressive symptoms (DASS-D)	10.24 (9.53)	9.07 (8.48)	0.41
Anxiety symptoms (DASS-A)	7.01 (7.31)	6.76 (6.96)	0.82

All values are presented in the form of mean (SD), unless otherwise stated. DASS-A = anxiety subscale of the 21-item Depression, Anxiety and Stress Scales (DASS-21); DASS-D = depression subscale of the DASS-21; SES = socioeconomic status

Table 2 Proportions of current physical context, social context, and activity reported in the daily lives of young people during dine-in ban and dining-as-usual periods

	Dine-in ban group ($n=83$)	Dine-as-usual group ($n=82$)	p
Physical context			
Home (core and extended family)	**71.4 (2511)**	**67.4 (2597)**	**<0.001**
Home (friends)	2.4 (86)	1.9 (73)	0.10
School	**3.7 (130)**	**2.5 (98)**	**<0.001**
Office	5.5 (194)	7.2 (278)	0.003
Public transport/on a bike/in a car	4.5 (160)	5.3 (203)	0.15
Other indoors	**6.5 (228)**	**9.9 (383)**	**<0.001**
Other outdoors	6.0 (211)	5.8 (224)	0.74
Social context			
Family (core and extended)	42.3 (1496)	45.5 (1760)	0.006
Friends	12.2 (432)	12.3 (476)	0.91
Classmates/colleagues	7.1 (250)	5.9 (228)	0.039
Teachers/supervisors	0.7 (24)	1.0 (39)	0.12
Strangers	**1.0 (36)**	**2.1 (80)**	**<0.001**
Alone	**36.7 (1297)**	**33.2 (1285)**	**0.002**
Current activity			
Active leisure activities	5.3 (187)	6.6 (256)	0.017
Passive leisure activities	36.8 (1296)	35.0 (1347)	0.093
In class/at work	16.1 (567)	14.3 (550)	0.028
Daydreaming	3.6 (125)	4.3 (167)	0.086
Going somewhere	6.0 (212)	7.2 (277)	0.045
Eating/drinking	11.8 (414)	12.5 (480)	0.36
Self-care	**3.4 (118)**	**5.0 (192)**	**0.001**
Household chores	1.6 (57)	2.2 (84)	0.080
Other activities	15.4 (542)	13.0 (500)	0.003

All statistics are presented in the form of percentages (%) and number of momentary beep responses (N). Significant differences in the proportions of current context and activity after the Bonferroni-corrected cut-off of $p=0.002$ are in boldface

positive affect ($\beta=-0.17$, SE = 0.06, $p=0.003$). Younger age ($\beta=-0.18$, SE = 0.06, $p=0.003$) and female gender ($\beta=-0.08$, SE = 0.03, $p=0.007$) were also significantly associated with reduced momentary positive affect.

The same analysis with baseline depressive and anxiety symptoms and SES included in the multilevel model showed that dine-in ban ($\beta=-0.15$, SE = 0.05, $p=0.008$), as well as younger age ($\beta=-0.16$, SE = 0.06, $p=0.007$) and being female ($\beta=-0.07$, SE = 0.03, $p=0.017$), remained significant for lower momentary positive affect. Higher levels of depressive symptoms were also associated with reduced momentary positive affect ($\beta=-0.14$, SE = 0.04, $p<0.001$), but not baseline anxiety symptoms or SES ($p>0.05$). Meanwhile, dine-in ban and other demographic variables showed no significant association with momentary negative affect in the multilevel model ($p>0.05$).

Effects of Dine-in Ban across Contexts and Activities

After Holm–Bonferroni correction, significantly lower levels of momentary positive affect were observed in the dine-in ban group when participants were in indoor locations, such as at family's home, in the office, and other indoor locations (Table 3). Reduced momentary positive affect in the dine-in ban group was also observed when participants were with their family, classmates/colleagues, teachers/supervisors, strangers, when they were alone, and when they were engaged in passive leisure activities, in class/at work, daydreaming, and when eating/drinking (Table 3). These findings have further been summarised and presented in Supplementary Material Table S3.

Effects of School Suspension as a Milder Form of Pandemic Lockdown

A separate multilevel analysis was performed to test the influence of school suspension on momentary affect. No significant association between school suspension and both momentary positive and negative affect was observed ($p>0.05$). Meanwhile, younger age ($\beta=-0.18$, SE = 0.06, $p=0.004$) and being female ($\beta=-0.07$, SE = 0.03, $p=0.011$) were also significantly associated

Table 3 Differences in level of momentary positive affect between the dine-in ban and dining-as-usual groups across current physical and social contexts and activities

	Momentary positive affect		
	Dine-in ban group ($n=83$)	Dining-as-usual group ($n=82$)	p
Physical context			
Home (core and extended family)	**2.84 (0.03)**	**3.27 (0.03)**	**0.003**
Home (friends)	3.74 (0.18)	3.68 (0.19)	0.92
School	2.82 (0.15)	2.72 (0.16)	0.25
Office	**2.38 (0.09)**	**2.75 (0.10)**	**<0.001**
Public transport/on a bike/in a car	3.28 (0.13)	3.35 (0.12)	0.32
Other indoors	**3.35 (0.10)**	**3.68 (0.08)**	**0.006**
Other outdoors	3.32 (0.13)	3.65 (0.11)	0.08
Social context			
Family (core and extended)	**2.91 (0.04)**	**3.44 (0.04)**	**0.002**
Friends	3.80 (0.08)	3.74 (0.07)	0.28
Classmates/colleagues	**2.93 (0.10)**	**2.98 (0.10)**	**0.02**
Teachers/supervisors	**2.40 (0.35)**	**3.77 (0.37)**	**0.01**
Strangers	**2.63 (0.21)**	**3.61 (0.25)**	**0.04**
Alone	**2.66 (0.04)**	**2.95 (0.04)**	**0.004**
Current activity			
Active leisure activities	3.55 (0.13)	3.75 (0.10)	0.18
Passive leisure activities	**3.00 (0.04)**	**3.24 (0.04)**	**0.03**
In class/at work	**2.42 (0.06)**	**2.96 (0.07)**	**<0.001**
Daydreaming	**2.83 (0.15)**	**3.19 (0.13)**	**0.02**
Going somewhere	3.36 (0.11)	3.25 (0.10)	0.08
Eating/drinking	**3.22 (0.08)**	**3.80 (0.07)**	**0.01**
Self-care	2.82 (0.14)	3.44 (0.13)	0.06
Household chores	2.83 (0.19)	3.66 (0.18)	0.49
Other activities	**2.72 (0.07)**	**3.05 (0.07)**	**0.002**

Values representing the level of momentary positive affect are presented in the form of mean (SD). Age, gender, years of education, beep number, and the interaction between beep number and dine-in ban were controlled for in all analyses, with p-values adjusted using the Holm-Bonferroni method to account for multiple comparisons. Significant p-values are in boldface

with reduced momentary positive affect in this model, but not with momentary negative affect ($p>0.05$). Their effects also remained significant even after controlling for baseline depressive symptoms (younger age: $\beta=-0.19$, SE = 0.06, $p=0.003$; female: $\beta=-0.08$, SE = 0.03, $p=0.007$).

Discussion

Our findings revealed an overall reduction in momentary positive affect in the current youth sample during the city-wide dine-in ban in Hong Kong. Diminished positive affect in daily life could represent a reduced capacity to experience pleasure or reduced engagement in pleasure-inducing activities as a consequence of external restrictions (Myin-Germeys et al., 2018). To explore these possibilities, we further investigated whether dine-in ban would result in a change in the daily activity patterns among young people, which may influence their levels of positive affect experienced in daily life. First, we found a significant increase in the time spent *at home* and time spent *alone* during the dine-in ban, both of which were found to be associated with reduced positive affect. Second, while dine-in ban appeared to have no notable impact on the time spent in some activities (e.g., being in office, being with colleagues or classmates, engaged in other passive leisure activities), significant reductions in momentary positive affect were still observed in these contexts among those in the dine-in ban group. Third and importantly, despite an overall reduction in positive affect during dine-in ban, momentary positive affect appeared to have been maintained by a small number of specific activities, such as being with friends, active leisure activities, and being outdoors, which may possibly offer protection against reductions in positive affect.

These observations suggested that the diminished positive affect during dine-in ban may not be explained entirely by a lack of opportunities to engage in pleasurable events. Instead, the reduced *ability* to experience pleasure on the same occasions may play a prominent role. Lower levels of momentary positive affect have been found to be associated with reduced activation in brain regions related to reward processing (e.g., the striatum) and disrupted reward anticipation (Myin-Germeys et al., 2018). Momentary positive affect has also been shown to be associated with more depressive symptoms and risks for future depressive symptoms (Naragon-Gainey, 2019; Zhaoyang et al., 2020). The finding that reduced momentary positive affect in daily life during dine-in ban remained even when accounting for baseline depressive and anxiety symptoms further suggested that the effects were not merely a result of pre-existing mental health conditions.

Interestingly, dine-in ban does not appear to have produced detectable changes in momentary negative affect. While interrelated, positive and negative affect have been considered to represent separate phenomena accompanied by differential underlying neurobiological mechanisms (Watson & Clark, 1997). In contrast to positive affect, which is more closely related to reward anticipation and resilience in daily life, negative affect may be more reflective of subjective emotions and vulnerability to daily life stress (Myin-Germeys et al., 2018; Wichers et al., 2012). Our observations suggested that dine-in ban may not directly affect subjective negative mood but may rather have more prominent influences on *diminishing the anticipation of rewarding experiences* in daily life. The use of ESM enabled a more fine-grained investigation into the specific effects of daily experiences on these two dimensions of momentary experiences.

Notably, the impact of COVID-19 lockdown on momentary positive affect was seen only when comparing dine-in ban with the dining-as-usual group and not when comparing school suspension with the school-as-usual group. As discussed earlier, dining out is common among the local population both as a part of daily routine and as a social activity. The extended periods of dine-in ban not only had considerable impacts on the patterns of daily activities of the general public but also on local businesses and the economy. In contrast, while disruptions caused by school suspension are acknowledged, its impact on the entire population is relatively lesser. For instance, alternatives to typical schooling (e.g., online teaching) were quickly put in place during periods of school suspension. In addition, while attending classes in person may offer a means for peer interactions for young people, some students may also feel relieved from the highly competitive education environment in Hong Kong (Shek & Li, 2016).

Implications for Future Research and Practice

Overall, findings from the current study can have important implications for future pandemic measures and mental health intervention planning. Clinicians and authorities are reminded to consider the mental health consequences resulting from specific lockdown policies on the population, especially when continued engagement in social activities is critical during the youth period. Suggestions for positive mood-inducing activities and effective means of coping when typical social activities are prohibited can be helpful.

In the literature, mental health suggestions for young people during the pandemic have been raised. For instance, strategies to improve sleep quality, strengthen resilience, cope with distress and negative emotions, and build authentic interpersonal relationships (e.g., with peers and family members) have been discussed (Ren et al., 2021). The call for more online or smartphone-based psychoeducation and psychological interventions (e.g., in Ho et al., 2020) is also relevant in the context of Hong Kong. Based on our findings, encouraging young people to engage in activities with potential protective effects (e.g., maintaining communications with friends, building habits to engage in active leisure activities, spending time outdoors while maintaining a safe level of social distancing) during severe lockdown periods could also be recommended.

Of note, when working with young people, further attention may be given to the younger and female subgroups. Previous research has found reduced brain activation during reward anticipation in adolescents below the age of 18 compared to young adults and adult populations (Bjork et al., 2010; Bretzke et al., 2021; Hoogendam et al., 2013), which may contribute to the consistent associations observed between younger age and reduced positive affect in our multilevel models. Disproportionate impacts of social deprivation (as a result of social distancing measures during COVID-19) on brain networks and behavioural developments in adolescents have indeed also been reported (Orben et al., 2020). Furthermore, as young females tend to place greater value on intimate peer relationships and are more likely to seek emotional support from peers (Rose & Rudolph, 2006), the reduced social interactions and in-person peer support during periods of more severe and restrictive COVID-19 measures might have contributed to the more pronounced effects observed on younger and female youths. These findings added to previous studies using self-reported questionnaires to highlight the heightened mental health risks in these populations across various lockdown scenarios under the pandemic (e.g., Loades et al., 2020; Pierce et al., 2020).

Strengths and Limitations

The current study was one of the few that adopted an ESM approach to explore the real-world impacts of the COVID-19 pandemic on momentary affect in young people. While the majority of existing studies during relied on retrospectively collected data or online surveys (e.g., Choi et al., 2020; Vindegaard & Benros, 2020), our current findings offered additional insights into the mental health consequences of COVID-19 with consideration of the impacts of different

pandemic measures on momentary affective states across contexts.

Overall, the findings we presented were consistent with the literature in support of the impact of the pandemic on mental health among young people (Mazza et al., 2020; Wong et al., 2021c). While a recent systematic review has reported no clear negative effects of COVID-19 on mental health (Sun et al., 2021), inconsistencies in the current literature may result from heterogeneity not only in the experience of COVID-19 across populations, but also in the populations sampled, choice of sampling method, and the use of assessment tools across studies (Dong et al., 2021). By examining two types of lockdown measures in Hong Kong (dine-in ban and school suspension), we added to this discussion to suggest that changes in momentary positive affect – and possibly reward anticipation – could also be dependent on the severity of COVID-19 lockdown measures.

We nonetheless also note several limitations in this study. First, our analyses were based on independent samples of young people before and during the specified lockdown periods. Although we ensured that the sociodemographic characteristics and psychiatric symptoms of participants between the dine-in ban and dining-as-usual groups were comparable, we were unable to examine potential changes in affective states before, during, and after restriction implementations. This was nonetheless a direct result of the ever-changing COVID-19 situation, where its intensity and time of lockdown implementations are difficult to anticipate. It would be informative in future studies, if possible, to recruit individuals willing to participate in a long-term low-intensity ESM study spanning several COVID-19 lockdown periods to examine their changes in affective state. The feasibility of this approach would depend on the epidemic situation in the particular society. Furthermore, previous studies have indeed reported that the local Hong Kong population generally shows strong adherence to protective measures, such as the use of face masks, the use of alcohol-based hand sanitisers, as well as social distancing regulations (Chan et al., 2021; Ho et al., 2021; Yan et al., 2021). While our focus was on the influences of large-scale population-wide COVID-19 restrictions on momentary affect, it would also be worthwhile to consider the possible additional roles played by individual differences in adherence to mandatory protective measures and the perceived distress associated with the various COVID-19 measures in future studies.

Conclusion

The use of data collected from an epidemiological youth sample in Hong Kong using the experience sampling method offered additional insights into the effects of different COVID-19 lockdown measures on the momentary affect and mental health states of young people. The importance of recognising COVID-19 as a complex and still-unfolding sequence of events leading to manifold societal consequences is highlighted. Ultimately, the impacts of COVID-19 and any future global crises must be evaluated in the context of the ongoing changes on the population level for the formulation of timely and appropriate mental health interventions and healthcare policies.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12144-022-03183-y.

Acknowledgements We would like to thank all participants and research colleagues of the HK-YES who contributed to the current study. We also would like to thank Ms. Christy Wong, our research colleague, for her support in verifying the details of the implementation of the different COVID-19 measures discussed in the manuscript.

Author Contribution SWMY, YYL, EYHC, CSMW, and CLMH conceptualised and designed the study. SWMY and YYL analysed the data and drafted the first version of the manuscript. SWMY, YYL, TYW, and CC were involved in data preprocessing and cleansing. SWMY, YYL, EYHC, CSMW, CLMH, YNS, TYW, BYHL, and IMG interpreted the data and contributed to further revisions of the manuscript. All authors approved the final version of the manuscript.

Funding The study was funded by Phase I of the Commissioned Study on Mental Health Survey, Food and Health Bureau, HKSAR Government (Reference number: MHS-P1 (Part 2)).

Data Availability The data presented in the current manuscript could be made available upon reasonable request. Enquiries may be submitted to the corresponding author.

Declarations

Conflict of Interest None to declare.

References

Bjork, J. M., Smith, A. R., Chen, G., & Hommer, D. W. (2010). Adolescents, adults and rewards: Comparing motivational neurocircuitry recruitment using fMRI. *PLoS One, 5*(7), e11440. https://doi.org/10.1371/journal.pone.0011440

Bretzke, M., Wahl, H., Plichta, M. M., Wolff, N., Roessner, V., Vetter, N. C., & Buse, J. (2021). Ventral striatal activation during reward anticipation of different reward probabilities in adolescents and adults. *Frontiers in Human Neuroscience, 15*, 649724. https://doi.org/10.3389/fnhum.2021.649724

Census and Statistics Department (2021). Key statistics on business performance and operating characteristics of the import/export, wholesale and retail trades, and accommodation and food services sectors (2020 Edition). Census and Statistics Department, Hong Kong Special Administrative Region.

Chan, E. Y. Y., Kim, J. H., Kwok, K. O., Huang, Z., Hung, K. K. C., Wong, E. L. Y., ... & Wong, S. Y. S. (2021). Population adherence to infection control behaviors during Hong Kong's first and third COVID-19 waves: A serial cross-sectional study. *International Journal of Environmental Research and Public Health, 18*(21), 11176.

Cheng, L. (2020). Hong Kong third wave: Officials scrap coronavirus-related ban on eating in restaurants after just 24 hours. *South China Morning Post*. https://www.scmp.com/news/hong-kong/

health-environment/article/3095283/hong-kong-third-wave-government-changes-mind. Accessed 21 Mar 2022.

Choi, E. P. H., Hui, B. P. H., & Wan, E. Y. F. (2020). Depression and anxiety in Hong Kong during COVID-19. *International Journal of Environmental Research and Public Health,* 17(10). https://doi.org/10.3390/ijerph17103740.

Chu, D. K. W., Hui, K. P. Y., Gu, H., Ko, R. L. W., Krishnan, P., Ng, D. Y. M., Liu, G. Y. Z., Wan, C. K. C., Cheung, M.-C., Ng, K.-C., Nicholls, J. M., Tsang, D. N. C., Peiris, M., Chan, M. C. W., & Poon, L. L. M. (2021). Introduction of ORF3a-Q57H SARS-CoV-2 variant causing fourth epidemic wave of COVID-19, Hong Kong. *China. Emerging Infectious Diseases, 27*(5), 1492–1495. https://doi.org/10.3201/eid2705.210015

Czeisler, M. É., Wiley, J. F., Facer-Childs, E. R., Robbins, R., Weaver, M. D., Barger, L. K., ... & Rajaratnam, S. M. (2021). Mental health, substance use, and suicidal ideation during a prolonged COVID-19–related lockdown in a region with low SARS-CoV-2 prevalence. *Journal of Psychiatric Research, 140*, 533–544. https://doi.org/10.1016/j.jpsychires.2021.05.080.

Dong, F., Liu, H. L., Dai, N., Yang, M., & Liu, J. P. (2021). A living systematic review of the psychological problems in people suffering from COVID-19. *Journal of Affective Disorders, 292*, 172–188. https://doi.org/10.1016/j.jad.2021.05.060

Hao, F., Tan, W., Jiang, L. I., Zhang, L., Zhao, X., Zou, Y., ... & Tam, W. (2020). Do psychiatric patients experience more psychiatric symptoms during COVID-19 pandemic and lockdown? A case-control study with service and research implications for immunopsychiatry. *Brain, Behavior, and Immunity, 87*, 100–106.

Ho, C. S., Chee, C. Y., & Ho, R. C. (2020). Mental health strategies to combat the psychological impact of COVID-19 beyond paranoia and panic. *Annals, Academy of Medicine, Singapore, 49*(1), 1–3.

Ho, L. K. K., Fong, C. S., & Wan, T. T. (2021). High level of (passive) compliance in a low-trust society: Hong Kong citizens' response towards the COVID-19 lockdown. *Policing: A Journal of Policy and Practice, 15*(2), 1046–1061.

Hoogendam, J. M., Kahn, R. S., Hillegers, M. H. J., van Buuren, M., & Vink, M. (2013). Different developmental trajectories for anticipation and receipt of reward during adolescence. *Developmental Cognitive Neuroscience, 6*, 113–124. https://doi.org/10.1016/j.dcn.2013.08.004

Kämpfen, F., Kohler, I. V., Ciancio, A., Bruine de Bruin, W., Maurer, J., & Kohler, H.-P. (2020). Predictors of mental health during the Covid-19 pandemic in the US: Role of economic concerns, health worries and social distancing. *PLoS One, 15*(11), e0241895. https://doi.org/10.1371/journal.pone.0241895

Lau, S. M., Chan, Y. C., Fung, K. K., Hung, S. L., & Feng, J. (2021). Hong Kong under COVID-19: Roles of community development service. *International Social Work, 64*(2), 270–274.

Le, H. T., Lai, A. J. X., Sun, J., Hoang, M. T., Vu, L. G., Pham, H. Q., ... & Ho, C. S. (2020). Anxiety and depression among people under the nationwide partial lockdown in Vietnam. *Frontiers in Public Health, 8*, 656.

Loades, M. E., Chatburn, E., Higson-Sweeney, N., Reynolds, S., Shafran, R., Brigden, A., Linney, C., McManus, M. N., Borwick, C., & Crawley, E. (2020). Rapid systematic review: The impact of social isolation and loneliness on the mental health of children and adolescents in the context of COVID-19. *Journal of the American Academy of Child and Adolescent Psychiatry, 59*(11), 1218–1239.e1213. https://doi.org/10.1016/j.jaac.2020.05.009

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the depression anxiety stress scales (DASS) with the Beck depression and anxiety inventories. *Behaviour Research and Therapy, 33*(3), 335–343. https://doi.org/10.1016/0005-7967(94)00075-u

Mazza, C., Ricci, E., Biondi, S., Colasanti, M., Ferracuti, S., Napoli, C., & Roma, P. (2020). A Nationwide survey of psychological distress among Italian people during the COVID-19 pandemic: Immediate psychological responses and associated factors. *International Journal of Environmental Research and Public Health, 17*(9). https://doi.org/10.3390/ijerph17093165.

Meers, K., Dejonckheere, E., Kalokerinos, E. K., Rummens, K., & Kuppens, P. (2020). mobileQ: A free user-friendly application for collecting experience sampling data. *Behavior Research Methods, 52*(4), 1510–1515. https://doi.org/10.3758/s13428-019-01330-1

Myin-Germeys, I., Kasanova, Z., Vaessen, T., Vachon, H., Kirtley, O., Viechtbauer, W., & Reininghaus, U. (2018). Experience sampling methodology in mental health research: New insights and technical developments. *World Psychiatry, 17*(2), 123–132. https://doi.org/10.1002/wps.20513

Naragon-Gainey, K. (2019). Affective models of depression and anxiety: Extension to within-person processes in daily life. *Journal of Affective Disorders, 243*, 241–248. https://doi.org/10.1016/j.jad.2018.09.061

Office of the Government Economist (2021). *Half-yearly Economic Report 2021*. Financial Secretary's Office, Hong Kong Special Administrative Region.

Orben, A., Tomova, L., & Blakemore, S. J. (2020). The effects of social deprivation on adolescent development and mental health. *Lancet Child & Adolescent Health, 4*(8). https://doi.org/10.31234/osf.io/7afmd.

Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., McManus, S., & Abel, K. M. (2020). Mental health before and during the COVID-19 pandemic: A longitudinal probability sample survey of the UK population. *Lancet Psychiatry, 7*(10), 883–892. https://doi.org/10.1016/S2215-0366(20)30308-4

Ren, Z., Xin, Y., Wang, Z., Liu, D., Ho, R. C., & Ho, C. S. (2021). What factors are most closely associated with mood disorders in adolescents during the COVID-19 pandemic? A cross-sectional study based on 1,771 adolescents in Shandong Province. *China. Frontiers in Psychiatry, 12*, 728278.

Rodríguez-Hidalgo, A. J., Pantaleón, Y., Dios, I., & Falla, D. (2020). Fear of COVID-19, stress, and anxiety in university undergraduate students: A predictive model for depression. *Frontiers in Psychology, 11*, 591797.

Rose, A. J., & Rudolph, K. D. (2006). A review of sex differences in peer relationship processes: Potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin, 132*(1), 98–131. https://doi.org/10.1037/0033-2909.132.1.98

Shek, D. T. L., & Li, X. (2016). Perceived school performance, life satisfaction, and hopelessness: A 4-year longitudinal study of adolescents in Hong Kong. *Social Indicators Research, 126*, 921–934. https://doi.org/10.1007/s11205-015-0904-y

Sun, Y., Wu, Y., Bonardi, O., Krishnan, A., He, C., Boruff, J. T., et al. (2021). Comparison of mental health symptoms prior to and during COVID-19: Evidence from a living systematic review and Meta-analysis. *medRxiv*. https://doi.org/10.1101/2021.05.10.21256920

Taquet, M., Luciano, S., Geddes, J. R., & Harrison, P. J. (2021). Bidirectional associations between COVID-19 and psychiatric disorder: Retrospective cohort studies of 62 354 COVID-19 cases in the USA. *The Lancet Psychiatry, 8*(2), 130–140.

Thorisdottir, I. E., Asgeirsdottir, B. B., Kristjansson, A. L., Valdimarsdottir, H. B., Jonsdottir Tolgyes, E. M., Sigfusson, J., Allegrante, J. P., Sigfusdottir, I. D., & Halldorsdottir, T. (2021). Depressive symptoms, mental wellbeing, and substance use among adolescents before and during the COVID-19 pandemic in Iceland: A longitudinal, population-based study. *Lancet Psychiatry, 8*(8), 663–672. https://doi.org/10.1016/S2215-0366(21)00156-5

Tran, B. X., Nguyen, H. T., Le, H. T., Latkin, C. A., Pham, H. Q., Vu, L. G., et al. (2020). Impact of COVID-19 on economic well-being and quality of life of the Vietnamese during the national social

distancing. *Frontiers in Psychology*, 2289. https://doi.org/10.3389/fpsyg.2020.565153

Trull, T. J., & Ebner-Priemer, U. W. (2009). Using experience sampling methods/ecological momentary assessment (ESM/EMA) in clinical assessment and clinical research: Introduction to the special section. *Psychological Assessment, 21*(4), 457–462. https://doi.org/10.1037/a0017653

van de Groep, S., Zanolie, K., Green, K. H., Sweijen, S. W., & Crone, E. A. (2020). A daily diary study on adolescents' mood, empathy, and prosocial behavior during the COVID-19 pandemic. *PLoS One, 15*(10), e0240349. https://doi.org/10.1371/journal.pone.0240349

Vindegaard, N., & Benros, M. E. (2020). COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity, 89*, 531–542. https://doi.org/10.1016/j.bbi.2020.05.048

Wan, K. M., Ho, L. K. K., Wong, N. W., & Chiu, A. (2020). Fighting COVID-19 in Hong Kong: The effects of community and social mobilization. *World Development, 134*, 105055. https://doi.org/10.1016/j.worlddev.2020.105055

Wang, K., Shi, H. S., Geng, F. L., Zou, L. Q., Tan, S. P., Wang, Y., ... & Chan, R. C. (2016). Cross-cultural validation of the depression anxiety stress scale–21 in China. *Psychological Assessment, 28*(5), e88–e100.

Wang, C., Chudzicka-Czupała, A., Grabowski, D., Pan, R., Adamus, K., Wan, X., ... & Ho, C. (2020). The association between physical and mental health and face mask use during the COVID-19 pandemic: A comparison of two countries with different views and practices. *Frontiers in Psychiatry, 11*, 569981.

Wang, C., Chudzicka-Czupała, A., Tee, M. L., Núñez, M. I. L., Tripp, C., Fardin, M. A., ... & Sears, S. F. (2021). A chain mediation model on COVID-19 symptoms and mental health outcomes in Americans, Asians and Europeans. *Scientific Reports, 11*(1), 1–12.

Watson, D., & Clark, L. A. (1997). Extraversion and its positive emotional core. In *Handbook of personality psychology* (pp. 767–793). Academic Press.

Wichers, M., Lothmann, C., Simons, C. J. P., Nicolson, N. A., & Peeters, F. (2012). The dynamic interplay between negative and positive emotions in daily life predicts response to treatment in depression: A momentary assessment study. *British Journal of Clinical Psychology, 51*(2), 206–222. https://doi.org/10.1111/j.2044-8260.2011.02021.x

Wong, S. M. Y., Hui, C. L. M., Wong, C. S. M., Suen, Y. N., Chan, S. K. W., Lee, E. H. M., Chang, W. C., & Chen, E. Y. H. (2021a). Mental health risks after repeated exposure to multiple stressful events during ongoing social unrest and pandemic in Hong Kong: The role of rumination: Risques pour la santé mentale après une exposition répétée à de multiples événements stressants d'agitation sociale durable et de pandémie à Hong Kong: Le rôle de la rumination. *The Canadian Journal of Psychiatry, 66*(6), 577–585.

Wong, S. M. Y., Hui, C. L. M., Wong, C. S. M., Suen, Y. N., Chan, S. K. W., Lee, E. H. M., Chang, W. C., & Chen, E. Y. H. (2021b). Prospective prediction of PTSD and depressive symptoms during social unrest and COVID-19 using a brief online tool. *Psychiatry Research, 298*, 113773.

Wong, S. M. Y., Hui, C. L. M., Suen, Y. N., Wong, C. S. M., Chan, S. K. W., Lee, E. H. M., et al. (2021c). The impact of social unrest and pandemic on mental health of young people in Hong Kong: The transdiagnostic role of event-based rumination. *Australian & New Zealand Journal of Psychiatry, 56*(4), 376–384.

Wong, S. M. Y., Ip, C. H., Hui, C. L. M., Suen, Y. N., Wong, C. S. M., Chang, W. C., et al. (in press). Prevalence and correlates of suicidal behaviours in a representative epidemiological youth sample in Hong Kong: the significance of suicide-related rumination, family functioning, and ongoing population-level stressors. *Psychological Medicine*.

Wong, S. M. Y., Lam, B. Y. H., Wong, C. S. M., Lee, H. P. Y., Wong, G. H. Y., Lui, S. S. Y., et al. (2021d). Measuring subjective stress among young people in Hong Kong: validation and predictive utility of the single-item subjective level of stress (SLS-1) in epidemiological and longitudinal community samples. *Epidemiology and Psychiatric Sciences*, 30.

Yan, E., Lai, D. W., Lee, V. W., & Ng, H. K. (2021). Predicting public adherence to COVID-19 preventive measures: A cross-sectional study in Hong Kong. *International Journal of Environmental Research and Public Health, 18*(23), 12403.

Yau, C. (2022). 'All doom and gloom': Thousands of Hong Kong restaurants shut down, suspend operations as Covid-19 cases bring harsh restrictions. *South China Morning Post*. https://www.scmp.com/news/hong-kong/hong-kong-economy/article/3166802/all-doom-and-gloom-thousands-hong-kong-restaurants. Accessed 21 Mar 2022.

Zhaoyang, R., Scott, S. B., Smyth, J. M., Kang, J. E., & Sliwinski, M. J. (2020). Emotional responses to stressors in everyday life predict long-term trajectories of depressive symptoms. *Annals of Behavioral Medicine, 54*(6), 402–412. https://doi.org/10.1093/abm/kaz057