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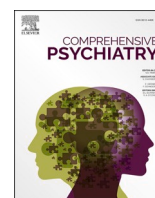
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Lifestyle behaviours and mental health and wellbeing of tertiary students during COVID-19 lockdown in Australia: A cross-sectional study

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ABSTRACT

Background: Australia experienced significant COVID-19 lockdown restrictions throughout 2020 that had an impact on mental health and disrupted health-promoting lifestyle behaviours. Lockdowns may have exacerbated existing mental health concerns among tertiary students, who experience higher levels of mental health concerns compared to the wider community. This study aimed to investigate the association between modifiable lifestyle factors and wellbeing of students at a Melbourne-based tertiary education institution during COVID-19 lockdown.

Methods: This quantitative, cross-sectional study was conducted across campuses in Melbourne and Sydney. Data was collected via online questionnaire during the 7th week of a second-wave lockdown. Descriptive statistics were calculated for demographic variables ($n = 239$). Linear regression models were estimated to determine multivariate associations between lifestyle variables and psychological distress.

Results: Participants were on average 30.98 years old ($SD = 9.78$), predominantly female, domestic students, undergraduate, not the first member of their family to attend university and living out of family home. Mindfulness, diet quality, sleep quality and moderate-vigorous physical activity (MVPA) were all inversely correlated with psychological distress. Unadjusted and adjusted models show that mindfulness, sleep quality, and MVPA were all independently inversely related to psychological distress. Greater mindfulness, sleep quality and engagement in MVPA were associated with lower psychological distress during COVID-19 lockdowns.

Limitations: As this study is cross-sectional and we cannot rule out reverse causality.

Conclusion: This study highlights the potential for lifestyle focused mental-health promotion delivered through tertiary education institutions to support students in times of crisis as well as more generally.

1. Introduction

Due to the COVID-19 pandemic, various lockdown restrictions were imposed across Australia throughout 2020 [81]. In response to a second wave, Melbournians experienced 112 days of continuous lockdown, with strict restrictions including a 5 km travel limit, only four legal reasons to leave home; shopping for food and supplies that you need, care and caregiving, exercise and work and study if you can't do it from home. Additionally, all school and higher education students required to learn from home. In total, those living in Melbourne spent over 23 weeks in lockdown. The COVID-19 pandemic has caused great uncertainty,

isolation, disruption to routine and has had significant impacts on mental health globally [82]. Combined with the stress regarding the threat of contracting the virus, time spent in mandated isolation has been shown to have negative impacts on mental health [7] and is associated with increased psychological distress [56].

While the pandemic has impacted many groups of the population, tertiary students are particularly vulnerable to compromised mental wellbeing. Tertiary students experience various academic, financial and social stressors that have a detrimental effect on mental health and wellbeing [57]. Approximately 1 in 5 university students will experience mental-ill health annually, and tertiary students experience

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psychological distress at rates much higher than their non-student peers [73]. This cohort may be particularly vulnerable, as rates of mental health concerns are high among adolescents and emerging adults, who form a significant portion of the student body [3,8,40]. During the COVID-19 pandemic, university students have reported concerns about academic performance as well as difficulty concentrating, poor sleep, limited social interactions and increased stress and anxiety due to health concerns [13,37,71]. In Australia, a survey of 787 university students identified that the majority of students (65.3%) reported low or very-low wellbeing during the pandemic [21].

Lockdown restrictions impacted aspects of lifestyle that are associated with psychological wellbeing among this population, such as social connectedness, physical activity and sleep [25,45,48]. Lifestyle factors including diet, physical activity, mindfulness, sleep, social interaction and avoidance of drugs and alcohol have been noted as prevention and complementary treatment approaches for anxiety and depression [65,66] and show benefits for psychological wellbeing [29]. However, during COVID-related restrictions, tertiary students have reported increased stress [37], more sitting time [62], reduced physical activity [32], disrupted sleep [71], increased energy intake [32] and increased intake of processed foods [26]. The relationship between lifestyle and mental health is particularly important to tertiary aged-students, given the prevalence of psychological distress is high and lifestyle behaviours among young adults are often poor [1,24,41]. Importantly, lifestyle factors are readily modifiable and may provide a beneficial prevention and intervention opportunity among tertiary students, which supports mental health promotion as well as student retention [15,28,44]. Given the potential for lifestyle behaviours to support mental health, this study aimed to investigate the association between modifiable lifestyle factors and wellbeing of students at a Melbourne-based tertiary education institution during COVID-19 lockdown.

2. Methods

2.1. Setting

This cross-sectional study was conducted across campuses of a metropolitan university in Melbourne and Sydney, Australia. Over 90% of domestic students at this university are enrolled at campuses in Melbourne. However, all responses received were from participants attending one campus in Melbourne's West.

2.2. Participants

Cross-sectional data were collected at baseline from participants who consented to participate in an online yoga program to promote mental health during lockdown. Approximately 24,000 students, including Higher Education, Technical and Further Education (TAFE) and Research Students were invited to partake in the program using the student mailing list. Students were eligible to participate if they had not engaged in yoga or meditation more than five times in the previous six months, with no other exclusion criteria. Baseline data was collected during lockdown (which required not leaving the house for more than 60 min per day, and only doing so to access essential services or to exercise for a maximum of 60 min per day, staying within 5 km of home, not leaving the house between 8 pm-5 am) from all students who consented to participate in the pre-recorded yoga program. All procedures involving human participants were approved by the Human Research Ethics Committee (HRE19-190) and complied with the ethical standards of this institutional committee. Informed consent was obtained from all participants using online submission.

2.3. Research design

In the current study, we have reported the cross-sectional mental health and wellbeing data that were collected using an online

questionnaire at baseline, during the 7th week of second-wave lockdown and study from home education delivery, in Melbourne, Australia.

2.4. Research measures

In the current paper, we present only the baseline time-point data. Collected demographic variables included age, gender, employment, educational history, and relationship information, adapted from the Australian Bureau of Statistics census questions.

2.5. Depression, Anxiety and Stress Scale (DASS-21)

The *Depression, Anxiety and Stress Scale (DASS-21)*, a validated self-report measure, was used to measure psychological distress (Cronbach's $\alpha = 0.92$) [34,83]. The DASS-21 as a single measure (compared with classification into subcategories depression, anxiety and stress) has considerable validity for the total scale Chronbachs $\alpha = 0.93$ (95% CI = 0.93–0.94) and has been found to have greater reliability than each of the DASS-21 subscales [34]. There is also evidence that young people tend to report a more generalised negative mood/physiological arousal, rather than differentiations between depression, anxiety and stress scales [23]. Psychological distress has been identified as the latent variable on the DASS-21 among young adults, for which depression, anxiety and stress were indicators [43].

2.6. Mindfulness

Hypothesised protective factors on mental health were assessed using the *Freiburg mindfulness inventory (FMI)*, a 14 item self-report measure of mindfulness (FMI-14, Cronbachs $\alpha = 0.86$) [59,77]. The FMI asks about experiences of mindfulness (e.g. "I sense my body whether eating, cooking, cleaning or talking" of "I accept unpleasant experiences") and participants respond on a scale from 1 (rarely) to 4 (almost always). Items include FMI scores range from 14 to 56, where higher scores represent greater mindfulness.

2.7. Diet

Starting the Conversation Diet Instrument is an eight-item food-frequency questionnaire that asks about frequency of intake of fast food, fruit and vegetables, sweetened beverages, protein sources, chips/crackers, desserts and added fats over the past few months [59]. Each item is scored from 0 to 2, where more frequent intake of healthy foods (i.e., fruits and vegetables are indicated by high scores, and more frequent intake of unhealthy foods (i.e. fast foods) are indicated by low scores. Scores on Starting the Conversation Diet Instrument range from 0 to 16, with higher scores indicating greater diet quality.

2.8. Sleep

An abbreviated version of the *Pittsburgh Sleep Quality Index* (Cronbachs $\alpha = 0.61$) [11] was used to measure sleep quality based on subjective sleep quality, latency, duration, efficiency, and daytime dysfunction. Sleep quality was rated on a scale of 0 (very bad) to 3 (very good).

Sleep latency was scored ≤ 15 min = 3; 16–30 min = 2; 31–60 min = 1, >60 min = 0. Sleep duration was scored >7 h = 3; 6–7 = 2; 5–6 = 1; <5 = 0. Sleep efficiency was calculated (total # of hours asleep)/(total # of hours in bed) x 100, and scored >85% = 3, 75%–84% = 2, 65%–74% = 1, <65% = 0. Finally, daytime dysfunction was rated on a 4-point Likert scale where 0(three or more times per week) and 3 (not during the past month). All components were summed for a total sleep score ranging 0–15, where higher scores equalled better sleep.

2.9. Moderate-vigorous physical activity

The *International Physical Activity Questionnaire Short Form* to assess moderate-vigorous physical activity (MVPA), which was assessed using MET-minutes [17]. MET minutes for moderate - vigorous activity were computed by multiplying MET score (4.0 for moderate, 8.0 for vigorous) with duration (minutes) of activity and frequency (days) of activity. Total MET minutes for moderate and vigorous activity were then summed for a continuous score.

2.10. Statistical analyses

The dataset was checked for missingness. Overall, 7.68% of values were missing, and data were missing completely at random (Little's $\chi^2 = 204.97, p = .711$). However, to retain all cases and increase statistical power, missing data was imputed using multiple imputations. A total of 10 imputed datasets were created using Markov chain Monte Carlo with predictive mean matching. Imputation models were estimated to impute data for psychological distress and all modifiable health behaviours with all covariates and demographic variables included, as well as auxiliary variables that were highly correlated ($r < 0.50$) with psychological distress or modifiable health behaviours. Results from multiple imputed datasets were combined using Rubin's Rule [64].

Descriptive statistics were calculated for demographic variables. Differences in psychological distress based on demographic variables were estimated with independent sample *t*-tests for dichotomous demographic variables, linear regression with dummy codes for categorical demographic variables with more than two categories, and Pearson correlation for continuous demographic variables.

Pearson correlation coefficients were estimated to determine bivariate correlations between psychological distress and modifiable health behaviours. Linear regressions models were estimated to determine multivariate associations with psychological distress. First models were run unadjusted with MVPA, diet quality, sleep quality, and mindfulness as independent variables. Next models were run with the same independent variables and adjusted for the effect of age. The pooled *r*-squared for multivariate models were calculated as the average of *r*-squares from imputed datasets [75]. Pooled standardized coefficients were calculated based on standardized predictors and outcomes (i.e. *z*-scores), which were standardized before analysis and pooling [76].

3. Results

Of the total of 239 students completed the survey, 235 lived in Melbourne. Participants were on average 30.98 years old (SD = 9.78), predominantly female (87%), domestic students (85%), undergraduate (56%), not the first member of their family to attend university (62%)

Table 1
Participant demographics and differences in distress (DASS-21) based on demographic variables.

Variable	n	Psychological Distress M (SD)	p-value
Male	31	19.68 (10.85)	0.823
Female	208	20.24 (11.95)	
Domestic student	204	19.89(11.65)	0.363
International student	35	21.77(12.66)	
First family member to attend university	92	20.83(12.67)	0.439
Not first family member to attend university	147	19.76(11.24)	
Certificate or Diploma (REF)	47	20.23(12.39)	0.3300
Bachelor or Honours	133	20.98(11.84)	
Postdoctoral degree	59	18.27(11.16)	
Living in family home with parents	108	19.08(12.29)	0.283
Living out of family home	131	21.06(11.35)	

M = Mean, n = Sample size, SD=Standard Deviation, REF = Reference category.

and living out of the family home (55%). Table 1 shows demographic characteristics and differences in distress based on demographic variables. Participants reported a mean mindfulness score of 20.16 (SD 11.80, total scores range 14 to 56) indicating relatively low mindfulness. The mean diet quality score was 7.47 (SD 2.73, total score range 0 to 16), indicating substantial room for dietary improvement, which is comparable to a previous study among students [6]. Sleep quality, on average, among participants was poor (mean 4.18, SD 2.67, total score 0–15). The median MVPA score for participants was 607.90 (Q1 1980.00;Q3 1429.10), which is below averages reported elsewhere for similar cohorts [27,47]. Participants reported an average score on the DASS-21 scale of 20.16 (SD = 11.80, Median = 19.00), which is above previous reported averages for comparable age groups (median 7, mean 9.43; SD 9.66) [34], and those elsewhere reported among Australian university students [42], however, was similar or below the levels of psychological distress reported by adults in Europe, the United States and Asia during COVID-19 [78].

3.1. Relationship between modifiable health behaviours and psychological distress during lockdown

The correlations between health behaviours and psychological distress are in Table 2. Results show that mindfulness, diet quality, sleep quality and MVPA were all inversely correlated with psychological distress. Results from multivariate linear regression models are in Table 3. Results from both the unadjusted and adjusted models show that mindfulness, sleep quality, and MVPA were all independently inversely related to psychological distress. The unadjusted model and adjusted models explained 28.5% and 32.3% of the variance in psychological distress in university students during lockdown, respectively, indicating medium and large effect sizes [14].

4. Discussion

The current study aimed to investigate associations between modifiable lifestyle behaviours and the wellbeing of students at a Melbourne-based tertiary education institution during mandated COVID-19 lockdown with severe restrictions. Overall, it was found that Melbourne tertiary students were experiencing high levels of psychological distress. Additionally, on average, participants scored in the lower half of scales for each of the examined lifestyle behaviours. Overall, higher mindfulness, better sleep quality and greater engagement in MVPA were associated with lower levels of psychological distress during lockdown. Although diet quality was significantly correlated with fewer symptoms of psychological distress, it was not associated with psychological distress in the final adjusted multivariate model.

During lockdown, tertiary students were experiencing much higher levels of psychological distress compared to the general Australian adult population [18] and Melbourne-based university students prior to lockdown [42]. This increase in distress is consistent with studies conducted with university students during lockdown globally [25,84]. In a study of 1535 university students in Greece, 65% reported that their

Table 2
Correlations between study variables from multiply imputed data.

	1	2	3	4	5 ^a	6
1. Psychological distress	–					
2. Mindfulness	–0.447**	–				
3. Diet quality	–0.166*	0.151*	–			
4. Sleep quality	–0.291**	0.158*	0.041	–		
5. MVPA ^a	–0.272**	0.183*	0.178*	0.093	–	
6. Age	–0.254**	0.054	–0.120	0.134*	0.081	–

* $p < .05$, ** $p < .01$, *** $p < .001$.

MVPA = Moderate-to-vigorous physical activity.

^a Correlations were estimated using Spearman's rank order correlation coefficient.

Table 3

Multivariate association between modifiable health behaviours and distress from multiply imputed data.

Predictor	Unadjusted		b	p	Adjusted for age		b	p
	B	95%CI			B	95%CI		
Mindfulness	-0.471	-0.621, -0.322	-0.381	<0.001	-0.461	-0.605, -0.317	-0.373	<0.001
Diet quality	-0.332	-0.834, 0.169	-0.077	0.194	-0.467	-0.963, 0.029	-0.108	0.065
Sleep quality	-0.947	-1.478, -0.417	-0.215	<0.001	-0.834	-1.358, -0.315	-0.190	0.002
MVPA	-0.102	-0.184, -0.020	-0.157	0.015	-0.084	-0.165, -0.002	-0.129	0.044
r squared ^a			0.285				0.323	

MVPA = Moderate-to-vigorous physical activity.

CI = Confidence interval.

B = unstandardized regression coefficient.

b = standardized regression coefficient.

$$^a \text{ Pooled r squared calculated as } \left(\frac{1}{M} \sum_{m=1}^M \hat{r} \right)^2.$$

symptoms of anxiety had increased a lot since lockdown was enforced, and one third of respondents reported the same increase for depressive symptoms [58]. Similarly, perceived stress increased, while mental wellbeing decreased rapidly between the beginning of lockdown and the 5-week point in a sample of university students in the United Kingdom [68]. Students may be impacted more significantly than their non-student peers during the lockdown period. The turmoil of shifting to remote online learning, diminished in-person social interactions and access to student services in addition to what is generally a challenging environment (e.g., academic and financial pressures, significant lifestyle changes), is possibly exacerbating already heightened psychological distress in students [10].

Lockdown measures across the world are associated with disruptions to mental health-promoting behaviours [2]. Pre-pandemic evidence suggests that diet quality, physical activity, sleep quality and mindfulness are all predictors of good mental health [66]. The results of the current study also demonstrate low levels of healthy lifestyle behaviours, and are in partial agreement with previous literature, with sleep mindfulness, and MVPA remaining significantly associated with psychological distress in our final model. This has been demonstrated in research both prior to [22,50,53] and during COVID-19 lockdowns [4,38,61], highlighting the importance of mindfulness, sleep and physical activity to mental health. In the current study, mindfulness and sleep quality may have more directly addressed drivers of psychological distress during the pandemic (i.e., fear, worry, uncertainty), both of which have been shown to have benefits for student mental health in the past [4,36,53]. A previous meta-analysis has identified the benefits of digital CBT tools for treating insomnia [70], which may support improving sleep among this cohort without risk of COVID-19 spread. Findings supporting the inverse relationship between mindfulness and psychological distress may be of particular importance, as although other lifestyle interventions (diet, physical activity) have known benefits for mental health, they often benefit from supervision and support that may not be feasible under lockdown or crisis conditions. Previous interventions have shown mindfulness interventions delivered briefly or online to improve psychological distress [12,30,55,67], suggesting interventions targeting mindfulness may be the most feasible under pandemic or crisis conditions. As dispositional mindfulness is a modifiable factor, these findings highlight the potential for mindfulness-based strategies to support student wellbeing.

Although overall physical activity (e.g., incidental activity) is likely to have decreased during lockdown, analysis of big data from Australia, the UK and USA shows that community interest in exercise surged following lockdown and though it declined, remained higher than pre-lockdown [20]. This may be a result of physical activity being one of the only reasons to leave home, adding extrinsic motivation to many physical activities (e.g., walking, exercising outdoors). Despite reduced activity overall, students may have participated in leisure time physical

activity, which has positive associations with mental health [80].

Our finding of a lack of association between diet and psychological distress differs from previous literature [19,60,79]. There is evidence to suggest that diet can be used as a coping or escape-avoidance strategy during times of stress [19] and increases in emotional eating during COVID-19 have been demonstrated elsewhere [5]. Given that it is habitual diet over the long-term that has been associated with mental health [39], the relatively short-term changes resulting from lockdowns may not supersede the effects of habitual diet. However, the impact of short-term dietary changes as a result of a stressor on mental health has not been well studied.

Although few studies have examined relationships between both lifestyle behaviours and mental health among tertiary student populations during lockdown, studies have shown independent changes in both lifestyle [33,45,62] and mental health [49] among students during this time. The findings in the current study may be explained by unique pandemic lockdown conditions, characteristics of this sample, and the particular experience of tertiary education students at this time. On average, participants demonstrated low mindfulness, poor sleep, moderate diet quality and below average moderate-vigorous physical activity. As this study is cross-sectional, it is not clear whether these levels reflect increases or decreases in lifestyle behaviours compared to pre-pandemic levels. Given the low levels of lifestyle behaviours in this cohort, this may indicate that even small increases in these behaviours may be associated with improvements in mental health during times of crisis. Importantly, our sample was, on average, older than a typical sample of tertiary students ($M = 30$ years). This may mean that students in the current study may have additional responsibilities and stressors that impacted lifestyle behaviours, compared to a younger cohort, such as possible caregiving, employment or home-schooling responsibilities.

There are several limitations that warrant consideration in interpreting these results. Firstly, this study is cross-sectional in nature, which precludes examining the temporal nature of lifestyle behaviours on mental health, and we cannot rule out reverse causality. It is arguably equally plausible that changes in lifestyle behaviour are impacting mental health, as it is that changes in mental health are impacting lifestyle, and likely that the association is bidirectional [51]. However, the evidence related to this question of directionality indicates that interventions targeting lifestyle behaviours are associated with improvements in mental health. For example, a meta-analysis of physical activity interventions for people with mental illness showed that physical activity improved depression symptoms and quality of life among individuals with mental illness [63]. Additionally, a systematic review by Spijkerman et al., [72] identified that online mindfulness interventions had benefits for depression and stress reduction [72]. Similarly, a 2021 meta-analysis of randomised controlled trials demonstrated that improving sleep quality improved mental health, including depression, anxiety, rumination and stress [69]. These findings are in line with a

large meta-review of lifestyle psychiatry interventions which showed the critical role of modifiable lifestyle factors including physical activity, sleep, diet and smoking in the prevention and treatment of mental disorders [29]. Although the current study is not able to identify causal relationships between lifestyle factors and psychological distress, it adds to the larger body of literature that has indicated the direct links between lifestyle and mental health.

Further, as this study is unable to compare psychological distress during lockdown with pre-pandemic levels psychological distress, it cannot disentangle the causal relationships between lifestyle factors and psychological distress, or whether the relationship changed due to the pandemic and lockdowns. It does however that show that lifestyle and mental health are intimately linked, even in situations of high stress and uncertainly. Therefore the promotion of a healthy lifestyle remains important even in situations when behaviours that might be considered 'non-essential,' such as physical activity, might otherwise be ceased. This work supports earlier work highlighting the importance of lifestyle in mental health and extends earlier work by demonstrating that the relationship remains even in unpredicted, high stress situations. Additionally, this study does not allow for comparisons to students' pre-pandemic behaviours and wellbeing and thus cannot address the direct impact of lockdown on changes in behaviour and mental health. Finally, the average age of the current sample is slightly older than the previously reported average of 26 years and 11 months [9] and participants were predominantly female. Thus, our findings may not be generalisable to all tertiary students and participants in the current study may have slightly different behaviours due to age related factors (i.e. increased responsibilities, caregiving, etc.).

The current study has several strengths, including examining a range of protective lifestyle factors and their impact on wellbeing, and examining these relationships during extremely strict lockdown conditions. The findings add to the growing body of knowledge on tertiary student mental health during COVID-19 lockdown and has important implications for both a mental health prevention and treatment framework at tertiary education institutions [74]. (Sundarasan et al. [74] highlight the strong appeal for the tertiary education sector to acknowledge the critical need for policy and action it to effectively manage the impacts of COVID-19 on student wellbeing and be prepared for any similar crises in the future. Mindfulness-Based Interventions have demonstrated effectiveness in reducing psychological distress in university student samples generally [46] and in adult samples during COVID-19 lockdown [31]. In addition, sleep education has shown to improve sleep behaviours, sleep quality and reduce depressive symptoms in university students [35]. Similarly, university students who meet exercise guidelines report better overall and mental health in general [54] and throughout COVID-19 lockdown [52]. Mindfulness training and sleep hygiene education should at least be an available option to university students through their institutions, or as a component of their courses [16]. In addition, measures to promote and opportunities to engage in physical activity should be considered for students. Given the low cost and low risk nature of mindfulness practices, healthy sleep habits and regular exercise as modifiable health behaviours, and their clear benefits for mental wellbeing, all are critical considerations for wellbeing strategies. This has implications for how education institutions support individual lifestyle behaviours, and also provides support for institution-level programs and policies that encourage lifestyle approaches to mental health promotion. Future research should aim to understand how some students may have maintained positive lifestyle behaviours that are associated with mental health during times of crisis, as well as examining interventions to increase mindfulness and lifestyle behaviours generally and in crisis.

5. Conclusion

Mindfulness, sleep and moderate-vigorous physical activity were associated with decreased psychological distress among tertiary

students based in Australia, who experienced significant levels of psychological distress during COVID-19 lockdowns. This study highlights that the association between lifestyle factors and mental health exists even in unpredicted, high stress situations and therefore the potential for lifestyle focused mental-health promotion delivered through tertiary education institutions to support students in times of stress should be further explored. Future studies should investigate factors that allowed some students to maintain mental-health promoting behaviours during lockdown. Additionally, given that lifestyle interventions – particularly mindfulness - are relatively low cost and low risk to deliver, the feasibility of delivering these programs and addressing student needs and preferences should be investigated.

Author contributions

Alexandra G. Parker, Michaela C. Pascoe conceived the study, obtained research funding, contributed to data curation, Project administration. Alex Parker, Sarah Dash, Matthew Bourke, Kara Dadswell, Michaela C. Pascoe contributed to data analyses; investigation; methodology; writing - original draft; review & editing.

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Declaration of Competing Interest

All authors declare that they have no conflicts of interest.

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