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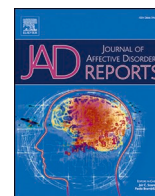
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Research Paper

Association between individuals' locus of control and mental health during the COVID-19 pandemic

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ABSTRACT

Background: Locus of control (LOC), individuals' perception that events occurring in life depend upon their own behavior and resources or not, has been shown to be associated with mental health disorders. However, few studies have considered the role of mental health prior to 2020 in this association. This study investigated the relationship between LOC and clinically significant symptoms of anxiety and/or depression during COVID-19 while controlling for preexisting clinically significant symptoms of anxiety and/or depression and psychoactive substance use.

Methods: Online, self-report data were collected from the 2009 French TEMPO cohort. From March 2020 to May 2021, 904 individuals answered at least one of nine questionnaires aiming to better understand the consequences of the pandemic on mental health. The outcome was self-reported clinically significant symptoms of anxiety and/or depression, and LOC was operationalized as a score. Generalized Estimating Equations models were used to account for repeated data.

Results: We found a 30% odds decrease of experiencing clinically significant symptoms of anxiety and/or depression during COVID-19 for a 10-points increase of the LOC score (odds-ratio (OR)= 0.70; 95% CI=0.61–0.81), when adjusting for preexisting symptoms of anxiety and/or depression, loneliness, COVID-19 related stress and risky alcohol consumption. In other words, the higher the LOC score increases, the LOC becoming internal, the lower the anxiety and/or depression symptoms risk becomes. No interactions were found between LOC and other confounding factors.

Limitations: LOC was assessed via the Internal Control Index, developed a few years ago.

Conclusion: In a context of pandemic-related strains, this study provided an insight into the association between personality traits and internalized symptoms. The present results confirm the need for more Cognitive Behavior Therapies to help coping with mental health and feeling of lack of control.

1. Introduction

Depressive and anxiety disorders are the two main diagnostic categories in common mental disorders (WHO, 2017), with increasing prevalence worldwide. According to the Global Burden of Disease (GBD) which provide a comprehensive pictures of mortality and disability across countries, time, age, and sex (IHME, 2014), the estimated number of people living with depression in the world increased by 18.4% between 2005 and 2015, and by 14.9% for anxiety disorders in the same period (Vos et al., 2016). COVID-19 has further exacerbated these

conditions, with self-reported symptoms of anxiety and depression on the rise (Cénat et al., 2021; Salari et al., 2020). In France, according to the French Public Health Agency, and using the validated Hospital Anxiety And Depression Scale (Bjelland et al., 2002; Stern, 2014), nearly 23% of the French general population showed anxiety symptoms in 2021 compared to 14% in 2017 (SPF, 2021).

Several characteristics were reported as mental health risk factors during COVID-19, including being female (Xiong et al., 2020), young age (Banks, 2020), financial difficulties (Gloster et al., 2020), COVID-19-like symptoms (Mary-Krause et al., 2021), fear of COVID-19

Abbreviations: LOC, locus of control; TEMPO, Trajectoires EpidéMiologiques en Population; ASR, adult self-report; ICI, internal control index; SEP, socio-economic position.

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and family caregiving (Yoshioka et al., 2021). Personality characteristics should also be considered as they reflect the cognitive, emotional, relational, experiential, motivational styles of individuals. The locus of control (LOC) (Rotter, 1954) is a key personality trait that refers to the notion of being in control or not of one's own life. Individuals with an external LOC consider that events depend on external factors that they cannot control (fate, chance or powerful others), while individuals with an internal LOC assume that events depend on their own actions and believe they can obtain reinforcements through work and effort (Sullivan, 2009). Research over the past three decades has shown external LOC to be associated with anxiety, indecisiveness (Archer, 1979; Hoehn-Saric and McLeod, 1985), hopelessness (Prociuk et al., 1976) but also aggression (Österman et al., 1999).

During COVID-19, associated lockdowns, social distancing and curfews occurred frequently, so reduced sense of control may have negatively affected mental health, even after returning to normal (Msetfi et al., 2022). Several studies have examined the association between LOC and mental health during the COVID-19 pandemic, and found that an external LOC is associated with a deterioration in mental health (Alat et al., 2021; Chela-Alvarez et al., 2022; Haywood and Mason, 2022; Huang et al., 2023; Iles-Caven et al., 2023; Krampe et al., 2021; Misamer et al., 2021; Origlio and Odar Stough, 2022; Sigurvinsdottir et al., 2020; Truzoli et al., 2021; Würtzen et al., 2021). In fact, an external LOC was associated with higher levels of anxiety or depressive symptoms (Sigurvinsdottir et al., 2020) as people with external LOC are more prone to cope emotionally with an unwanted situation, which could involve distancing, self-blaming, avoidance (Iles-Caven et al., 2023), or even problematic behaviors like problematic internet use (Truzoli et al., 2021). Feeling little influence on their lives, individuals may internalize COVID-19 threats (Krampe et al., 2021) and experience negative emotions like anxiety, particularly if they lack social support (Chela-Alvarez et al., 2022). On the contrary, an internal LOC was associated with lower levels of psychological stress during COVID-19 (Alat et al., 2021; Misamer et al., 2021). In fact, feeling in control in an uncertain pandemic could partly protect from its deteriorative effects on mental health. Individuals with an internal LOC and a proactive approach to negative events, like Copucian coping (Huang et al., 2023), have been shown to have healthier mental well-being (Santini et al., 2022) as they exhibit perseverance and effort in directing their lives. As research on the association between LOC and mental health during COVID-19 grows, the role of preexisting mental distress should be considered. Mental health during COVID-19 pandemic is controversial. Indeed, whereas a lot of studies showed anxiety and depression during COVID-19 (Jin et al., 2021; Wu et al., 2021) Kok et al. found that depressive, anxiety and worry symptoms were stable over time compared to pre-pandemic settings (Kok et al., 2022), whereas Andersen et al. found that preexisting clinically significant symptoms of anxiety and/or depression increased the risk of having similar symptoms during the pandemic by 6.73 times than those with no preexisting symptoms (Andersen et al., 2021). Similarly, individuals with bipolar disorder had significantly higher scores of stress and anxiety symptoms than those without a history of mental health issues, during the pandemic (Karantonis et al., 2021). A meta-analysis showed that change in mental health was highly variable across samples, and there was a small increase in mental health symptoms soon after the outbreak that decreased and was comparable to pre-pandemic levels by mid-2020 (Robinson et al., 2022). So, controlling for pre-pandemic mental health is crucial as it could be a confounding variable of occurrence of mental health problems during a health crisis. Origlio et al. found that pre-pandemic depressive symptoms predicted changes in depressive symptoms among students with an external LOC (Origlio and Odar Stough, 2022). However, data for pre-pandemic depressive symptoms were collected retrospectively, which could lead to memorization and notification biases. Moreover, significant associations between psychoactive substance use (tobacco, alcohol or marijuana) and mental health disorders have been reported (Degehardt and Hall, 2001; Smith et al., 2017); these factors could

serve as potential confounding factors.

This study adds to the existing research, by taking into account the role of preexisting anxiety and/or depression symptoms but also psychoactive substance use in the association between LOC and clinically significant symptoms of anxiety and/or depression during the COVID-19 pandemic, using prospective longitudinally collected data. We hypothesize that individuals with external LOC will be at higher odds of having clinically significant symptoms anxiety and/or depression during COVID-19 than individuals with internal LOC, independently of history of such symptoms and psychoactive substance use.

2. Material and methods

2.1. Study population

Data were collected from the TEMPO (Trajectoires EpidéMiologiques en POPulation) cohort started in 2009 to evaluate determinants of mental health difficulties and addictive behaviors in French young adults aged 22–35 years (Mary-Krause et al., 2021). Participants had previously participated in a study on children's mental health in 1991 and 1999 (Tamers et al., 2014), and were offspring of participants of the GAZEL cohort study (Goldberg et al., 2007), the only eligibility criteria to participate in TEMPO. First contacted in 2009, participants were since followed up via self-completed questionnaires in 2011, 2015 and 2018.

When the COVID-19 pandemic started in March 2020 in France, TEMPO participants were contacted to provide information on the consequences of the pandemic and lockdown on their mental health and addictive behaviors. Nine waves of data were collected from March 2020 to May 2021 as part of the TEMPO COVID-19 project, providing prospective and relevant data for our research questions. TEMPO—COVID participants had no specific inclusion criteria other than having previously participated in TEMPO. Weekly surveys were sent for the first five waves to assess changes in mental health and addictive behaviors during the lockdown, followed by bi-weekly surveys in the 6th and 7th waves not to overwhelm participants, and then two last surveys were sent respectively in June–July 2020 and between December 2020 and May 2021 to assess respectively short- and long-term evolutions of the mental health and addictive behaviors after the end of the first lockdown and the return to daily life (Supplementary Fig. 1). The particularity of this study is that it allows a comparison of the pre-pandemic and pandemic periods, thanks to a longitudinal follow-up in both periods. During lockdown, when the post office was not working properly, all self-completed questionnaires were sent online to TEMPO participants with valid email addresses ($n = 1224$). The last survey was also sent by post to participants without a valid email address ($n = 955$). Overall, 904 individuals completed at least one questionnaire across the nine study waves.

The TEMPO cohort received approval of bodies supervising ethical data collection in France, the Advisory Committee on the Treatment of Information for Health Research (Comité consultatif sur le traitement de l'information en matière de recherche dans le domaine de la santé, CCTIRS) and the French data protection authority (Commission Nationale de l'Informatique et des Libertés, CNIL, n°908,163).

2.2. Measures

2.2.1. Outcome: symptoms of anxiety and/or depression

Clinically significant anxiety and/or depression symptoms were assessed at each study wave using items from the Anxious/Depressed scale from the Achenbach System of Empirically Based Assessment (ASEBA) Adult-Self Report (ASR) (Achenbach and Rescorla, 2003). The ASR is a validated standardized self-administered questionnaire assessing different dimensions of mental health across different age groups, designed to measure symptoms, which may be indicative of psychiatric disorders (Rescorla and Achenbach, 2004). Studying symptoms has been found to be a valid indicator of disorders, but also gives the statistical

analyzes optimal statistical power (Waszczuk et al., 2017). It is a reliable and valid instrument which has demonstrated good psychometric properties in terms of sensitivity (80%) and specificity (95%) (Achenbach, 1991; Achenbach et al., 2017; Guerrero et al., 2020). Within this study, the ASR showed good internal consistency (Cronbach's alpha = 0.88), similarly to other studies (de Vries et al., 2020; Le Corff et al., 2018)

The questionnaire included 8 (wave 1) to 13 items (waves 2 to 9) due to an update of the ASR scale (Achenbach, 2015; "ASR," n.d.). TEMPO is a longitudinal cohort study, and the initial rationale was to use the same scale as previously in order to be in capacity to study participants' long-term trajectories of mental health. However, in subsequent waves of data collection, the scale was updated to have the modernized version and be in line with most recent studies, particularly given that the disparities between the two scales are not substantial with 8 identical items to those of the wave 1 version (Achenbach, 1991, 2015; Achenbach and Rescorla, 2003; Ivanova et al., 2015). Wave 1 data were included in the study as they were collected during the first week of the national lockdown and reflected participants' immediate mental health. Items were rated according to a 3-point Likert scale (0= "Not True", 1= "True Sometimes", 2= "Often true").

A crude score was first obtained by summing all items, and then transformed to a 0–100 scale and standardized with a T-score with mean equal to 50 and standard deviation equal to 10, in order to create a comparable measure between different waves of follow-up. According to the ASR guidelines, the 85th percentile as a threshold is mainly used to identify participants with clinically significant anxiety and/or depression symptoms (Achenbach, 1991). For all nine study waves, the values on the 85th percentile of the T-score distribution were calculated. These cut-off values were used to create a binary anxiety and/or depression variable at each wave (see **Supplementary Table 1** for the description of the ASR score at each wave).

2.2.2. Locus of control

The Locus of control (LOC) was measured using the Internal Control Index (ICI) (Duttweiler, 1984), a validated instrument that has showed good psychometric properties in terms of reliability and validity (Meyers and Wong, 1988). For the study, the questionnaire was translated by a proficient English and French speaker and then back translated. The adequacy of the translation was tested in a pilot study. Within this study, the ICI showed acceptable internal coherence (Cronbach alpha = 0.65).

The scale includes 28 items evaluated on a 5-point Likert scale (1= "Rarely", 2= "Occasionally", 3= "Sometimes", 4= "Frequently", 5= "Usually"), each item being scored from 1 to 5 (Corcoran et al., 1987). Scores for all items are summed to obtain the final LOC score, ranging from 28 to 140. According to the scientific literature (Jacobs, 1993; Smith, 1997), a high score reflects an internal LOC while a low score reflects an external LOC but there is no clear consensus on a threshold value defining the type of LOC. So we analyzed it as a continuous variable (per 10 points increase).

Participants' LOC was measured at study waves 8 and/or 9. LOC is a personality trait considered stable over time (Hovenkamp-Hermelink et al., 2019; Rotter, 1966) even after negative events such as job loss (Preuss and Hennecke, 2018) or financial hardship (Frondel et al., 2021). The LOC score in waves 8 and 9 of the TEMPO cohort showed a strong correlation ($r = 0.80, p < .0001$), and no significant difference was found between the scores at wave 8 or 9, suggesting that participants maintained the same LOC over time ($n = 238$). When participants reported their LOC twice, we chose the minimum LOC score. The score values are close between the 2 waves. Nevertheless, in order to assess the stability of our results, we performed sensitivity analyzes described below.

2.2.3. Potential confounding factors

2.2.3.1. Socio-demographics characteristics. Participants' socio-demographics characteristics included sex ("Female", "Male"), age (per 5 years increase), living situation ("With a partner and children", "With a partner but no children", "Without a partner"), which were collected the first wave they notified in TEMPO COVID-19. The Socio-Economic Position (SEP) was ascertained based on participants' highest educational level notified in different collection waves, the most recent occupational category, and type of work contract, and was defined as follows: "Intermediate or High SEP" and "Low SEP" (Redonnet et al., 2012).

2.2.3.2. Health characteristics. The existence of at least one medical condition ("No", "Yes") was self-reported by participants in the first TEMPO—COVID-19 questionnaire completed. The medical conditions included musculoskeletal disorders (28.7%), migraines (15.5%), nervous breakdowns (14.9%), obesity (13.7%), asthma (10.5%), cardiovascular disease (5.8%), chronic digestive diseases (3.7%), cancer (2.0%) or diabetes (1.9%).

Information on preexisting clinically significant symptoms of anxiety and/or depression was extracted from TEMPO cohort data collected in 2018, 2011 or 2009, the most recent information being taken into account. Self-reported clinically significant symptoms were assessed by the ASR (Rescorla and Achenbach, 2004) in 2009 and 2018 and by the Mini-International Neuropsychiatric Interview (MINI) (Lecrubier et al., 1997; Sheehan et al., 1997) in 2011. The MINI is a widely used instrument, with very good Kappa coefficient, sensitivity, specificity and test-retest reliability (Sheehan et al., 1997).

Subjects' loneliness was measured at each study wave by the 3-item UCLA (University of California, Los Angeles) Loneliness Scale (Russell et al., 1980), with each item scored from 1 ("Hardly Never") to 3 ("Often"). Following prior research, total scores were then calculated and dichotomized: individuals with a score < 6 were considered as "not feeling lonely" and individuals with a score ≥ 6 as "feeling lonely" (Steptoe et al., 2013). Participants also self-reported occurrence of COVID-19-like symptoms (fever, cough, muscle soreness, respiratory problems, loss of taste, loss of smell or fatigue) for each nine study waves. Participants were also asked if they were concerned about the COVID-19 situation at each wave ("Not concerned", "Moderately" and "Very concerned"). Loneliness, occurrence of COVID-19-like symptoms and concern about COVID-19 situation were then taken into account at each wave of TEMPO—COVID-19.

2.2.3.3. Psychoactive substance use. Data on psychoactive substance use such as alcohol, tobacco and cannabis, were collected for all study waves. Alcohol consumption was assessed by using questions from the AUDIT-10 questionnaire (WHO, 2001). Alcohol consumption was categorized as: "Not risky" for a consumption of alcohol once a week or less, and "Risky" for a consumption of at least 2 times per week (Choi et al., 2022). The frequency of tobacco use was categorized into 2 classes: "Non-smoker or occasional smoker" and "Regular smoker and ex-smoker" according to the question "Currently, are you? 1. A regular smoker; 2. A occasional smoker; 3. An ex-smoker; 4. Not a smoker". Alcohol and tobacco consumption were taken into account at each wave of TEMPO—COVID-19. Finally, cannabis use in the past year was categorized as "Never" and "More than once" according to the question "How many times did you use cannabis?" and was taken into account if at least one Yes was notified in each TEMPO—COVID-19 wave.

2.3. Statistical analyzes

Comparisons between LOC scores per participants' characteristics were performed using Student's t-test for binary variables, Pearson's correlation test for continuous variables or one-way Analysis of Variance

(ANOVA) for categorical variables. To determine factors associated with clinically significant symptoms of anxiety and/or depression and in order to take into account the repeated and correlated nature of the longitudinal data, we used Generalized Estimating Equations (GEE) models (Liang and Zeger, 1986) with an exchangeable correlation matrix. Moreover, it is the model that best fits the data insofar as subjects may not participate in all waves, so this model is robust to missing data at random, estimators obtained by GEE being resistant to a certain rate of missing data in the outcome and parameter estimates for the marginal model being consistent (Seaman and Copas, 2009). To consider all potential confounding factors, all those associated with symptoms of depression/anxiety with a *p*-value<0.2 (Bursac et al., 2008) in univariate analyzes (Supplementary Table 2) were included in the multivariate model.

In our study, the percentage of missing data for all confounding factors was less than 5%. For the LOC variable, the percentage of missing data was slightly higher (14%). Missing data were not completely at random (Little, 1988) but based on graphical assessment of missingness patterns and associated tests, we made the assumption that covariates were missing at random (MAR). Therefore, all missing confounding factors and the LOC were imputed using Multiple Imputations by Chained Equations (MICE) with Fully Conditional Specification (FCS) (Buuren et al., 2006) using *n* = 15 multiple imputations (Bodner, 2008). The study outcome was not imputed (Kontopantelis et al., 2017) and incomplete cases were removed. Nevertheless, the number of missing data is very low (supplementary Table 1). Lastly, interactions between LOC and confounding factors were tested. All analyzes, except the multiple imputation performed with R (version 4.0.2), were run using SAS® (version 9.4).

2.3.1. Sensitivity analyzes

To assess the stability of our results according to the choice of the LOC score variable, we performed two sensitivity analyzes: First, by including the LOC scores in wave 8 and in wave 9 when the subject responded to both waves and then by taking the maximum LOC score between wave 8 and 9.

3. Results

Before imputation, the LOC score was available for 685 participants from the TEMPO COVID-19 cohort study who provided data on their LOC during COVID-19. The LOC scores varied from 57 to 133 with an average score of 98.8 (±11.5: Standard Deviation (SD)).

Among the 685 participants, more than two thirds of the participants were female (66.2%), 40 years old on average, lived mostly with a partner and had an intermediate or high SEP (Table 1). Across all TEMPO study waves since the beginning of the COVID-19 pandemic, clinically significant symptoms of anxiety and/or depression were observed in 28.9% of participants on at least one occasion. LOC score was lower, i.e. more external, among women, participants with a history of clinically significant symptoms of anxiety and/or depression and those who felt lonely.

After adjustment on confounding factors (Table 2), we found a 30% odds decrease of experiencing clinically significant symptoms of anxiety and/or depression during COVID-19 for a 10-points increase of the LOC score (odds-ratio (OR)=0.70; 95% CI=0.61–0.81). In other words, the higher the LOC score increases, the LOC becoming internal, the lower the anxiety and/or depression symptoms risk become. Results of the sensitivity analyzes are close to those of the main analysis (Supplementary Table 3).

Moreover, females, persons with preexisting clinically significant symptoms of anxiety and/or depression, who report loneliness, concern about the COVID-19 pandemic and risky alcohol consumption, were also at elevated odds of clinically significant symptoms of anxiety and/or depression during the follow-up. No interactions were found between LOC and other confounding factors. All sensitivity analysis led to the

Table 1

Characteristics of TEMPO cohort participants according to their type of locus of control (March 2020 – May 2021).

	Total (n = 685)	LOC score (mean ± Standard Deviation)	p-value ¹
SOCIO-DEMOGRAPHIC CHARACTERISTICS			
Sex (n = 683)			
Female	452 (66.2%)	97.5 ± 11.3	<0.0001
Male	231 (33.8%)	101.4 ± 11.3	
Age (n = 683)			
Mean ± SD	40.2 ± 3.6		0.0053
Living situation (n = 681)			
Do not live with a partner	154 (22.6%)	98.3 ± 11.7	0.2904
Lives with partner but no children	76 (11.2%)	97.3 ± 10.8	
Lives with partner and children	451 (66.2%)	99.3 ± 11.5	
Socioeconomic position (n = 668)			
Intermediate or high	455 (68.1%)	100.2 ± 11.0	<0.0001
Low	213 (31.9%)	95.8 ± 11.9	
HEALTH CHARACTERISTICS			
Medical conditions² (n = 685)			
No	59 (8.6%)	100.2 ± 11.8	0.3254
Yes	626 (91.4%)	98.7 ± 11.4	
Clinically significant anxiety and/or depression symptoms at least once during follow-up			
No	487 (71.1%)	101.3 ± 10.6	<0.0001
Yes	198 (28.9%)	92.5 ± 11.1	
History of clinically significant anxiety and/or depression symptoms (n = 672)			
No	547 (81.4%)	100.5 ± 10.9	<0.0001
Yes	125 (18.6%)	90.6 ± 10.5	
Loneliness (n = 685)			
No	572 (83.5%)	99.6 ± 11.4	<0.0001
Yes	113 (16.5%)	94.7 ± 11.1	
COVID-19-like symptoms (n = 685)			
No	537 (78.4%)	98.9 ± 11.5	0.6323
Yes	148 (21.6%)	98.4 ± 11.6	
Concern about COVID-19 (n = 683)			
Not concerned	258 (37.8%)	99.7 ± 11.9	0.3015
Moderately	156 (22.8%)	98.4 ± 10.7	
Very concerned	269 (39.4%)	98.2 ± 11.5	
PSYCHOACTIVE SUBSTANCE USE			
Alcohol consumption (n = 670)			
Not risky	437 (65.2%)	99.1 ± 11.4	0.3642
Risky	233 (34.8%)	98.3 ± 11.5	
Tobacco (n = 671)			
Non-smoker or occasional smoker	443 (66.0%)	98.8 ± 10.7	0.8139
Former smoker or regular smoker	228 (34.0%)	99.0 ± 12.8	

(continued on next page)

Table 1 (continued)

	Total (n = 685)	LOC score (mean ± Standard Deviation)	p-value ¹
Cannabis use the past year (n = 595)			
Never	528 (88.7%)	99.1 ± 11.6	0.8440
More than once	67 (11.3%)	99.4 ± 10.1	

¹ Student's t-test for binary variables, Pearson's correlation test for continuous variables or one-way Analysis of Variance (ANOVA) for categorical variables.

² Medical conditions: musculoskeletal disorders, migraines, nervous breakdowns, obesity, asthma, cardiovascular disease, chronic digestive diseases, cancer or diabetes.

Table 2

Locus of control and clinically significant symptoms of anxiety and/or depression during the course of the COVID-19 pandemic: multivariate GEE model (Odds ratio (OR), 95% Confidence Interval (CI)): TEMPO cohort study (n = 904, March 2020-May 2021, France).

	Symptoms of anxiety and/or depression during follow-up ¹	p-value
	OR [95% CI]	
Locus of control (per 10 points increase)	0.70 [0.61 – 0.81]	<0.0001
Sex		
Male	1	
Female	1.85 [1.31 – 2.63]	0.0005
Living situation		
Lives with partner and children	1	
Lives with partner but no children	1.07 [0.67 – 1.70]	0.7811
Do not live with a partner	1.15 [0.81 – 1.63]	0.4336
Socioeconomic position		
Intermediate or high	1	
Low	1.24 [0.91 – 1.70]	0.1671
Medical conditions		
No	1	
Yes	1.58 [0.75 – 3.32]	0.2274
History of clinically significant symptoms of anxiety and/or depression		
No	1	
Yes	5.33 [3.86 – 7.35]	<0.0001
Loneliness		
No	1	
Yes	3.55 [2.88 – 4.39]	<0.0001
Concern about COVID-19		
Not concerned	1	
Moderately	1.27 [0.98 – 1.63]	0.0662
Very concerned	1.44 [1.12 – 1.84]	0.0040
Alcohol consumption		
Not risky	1	
Risky	1.42 [1.11 – 1.82]	0.0056

¹ Self-reported clinically significant anxiety and/or depression symptoms as indicated by scores exceeding validated 85th percentile cutoff value (ASR, Anxious and/or depressed scale) for all nine study waves during TEMPO COVID-19 (March 2020 -May 2021).

same conclusions, indicating that the minimum score choice did not alter the results (**Supplementary Table 3**).

4. Discussion

During COVID-19, while experiencing a deteriorated mental health is more likely in individuals with pre-existing mental illness (Andersen et al., 2021; Asmundson et al., 2020; Bendau et al., 2021), having an external LOC could also increase this risk (Iles-Caven et al., 2023; Krampe et al., 2021; Sigurvinsdottir et al., 2020). So, our study examined the association between LOC and clinically significant symptoms of anxiety and/or depression during the pandemic, controlling for this prior kind of symptoms collected longitudinally and not by memory, and found a 30% odds decrease of experiencing clinically significant symptoms of anxiety and/or depression during COVID-19 for a 10-points increase of the LOC score, in line with our hypothesis. In other words, individuals with a more external LOC are at higher risk of experiencing anxiety and/or depression symptoms than individuals with a more internal LOC. Krampe et al. (2021) explained that lack of control due to the virus and imposed restrictions reinforces a sense of powerlessness in individuals with external LOC, leading to impaired mental health. On the other hand, individuals with internal LOC attempt to maintain control through precautionary behaviors (mask-wearing, social distancing) (Alat et al., 2021) or positive coping mechanisms such as Confucian coping (Huang et al., 2023), leading to higher life satisfaction (Kesavayuth et al., 2022).

Associated concepts to the LOC are resilience and self-efficacy (Stewart and Yuen, 2011) which refers respectively to the process of adapting well to negative issues and the belief in the ability to achieve a goal (Bandura, 1977). Haywood and Mason (2022) reported that high self-efficacy may be protective for mental health because it pushes action, leading individuals to engage in fewer risk-taking behaviors during COVID-19 (Sigurvinsdottir et al., 2020). Similarly to the current study, one paper (Monistrol-Mula et al., 2022) reported that resilience was a protective factor against higher levels of anxiety and depressive symptoms during the pandemic, after adjusting for history of mental conditions. Therefore, there is a consensus that associated personality traits, such as LOC, resilience and self-efficacy are associated with mental health. Various theoretical models have been proposed to understand the etiological causes between personality traits and mental health (Klein et al., 2011; Widiger, 2011), including the Vulnerability model which theorizes that personality traits represent a risk or protective factor for the onset of mental disorder (Hakulinen et al., 2020). High neuroticism, for example, can contribute to mental health issues or amplify the impact of other risk factors. All in all, personality is an umbrella term referring to a large number of variables described in five various contexts from which that individual is embedded: historical, cultural, developmental, organizational and interpersonal (Veroff, 1983).

Furthermore, our findings suggest that the impact of clinically significant symptoms of anxiety and/or depression prior to 2020 on this kind of symptoms during the COVID-19 pandemic is far greater than the impact of the LOC. The vulnerability of subjects with preexisting mental disorders was still observed in the context of the pandemic (Holmes et al., 2020; Origlio and Odar Stough, 2022; Vindegaard and Benros, 2020) and could be explained by the continuity of participants' psychological vulnerability insofar disorders such as anxiety are fairly stable over time (Nes et al., 2007). In relation to this matter, a pre-COVID study reported that LOC showed equal stability estimates as symptom levels of anxiety and depression did over nine years (Hovenkamp-Hermelink et al., 2019).

In line with other studies, women were nearly twice more likely to experience anxiety and/or depression compared to men during COVID-19 (Pieh et al., 2020; Xiong et al., 2020). Participants were 3.55 times more likely to experience anxiety and/or depression when they felt lonely. No significant association between symptoms of anxiety and/or

depression and medical conditions was found. However, we adjusted on this variable to consider it as a potential confounding factor, as individuals with medical conditions and an external LOC may be less curious about their illness, reflecting the passive nature of external LOC (LaCaille and Patino-Fernandez, 2013). Moreover, the only psychoactive substance associated with clinically significant symptoms of anxiety and/or depression was alcohol. Studies have shown that subjects using tobacco or cannabis have more frequent symptoms of mental disorders (Degenhardt et al., 2001). In our study, no significant association was found between clinically significant symptoms of anxiety and/or depression and tobacco or cannabis use, which can be explained by the small representation of tobacco or cannabis smokers in our cohort. Data on treatment or medication for anxiety and/or depression was unavailable in the study. It may be an important factor in the relationship between LOC and anxiety and/or depression symptoms that should be controlled for, pharmacotherapy having shown significant benefits for individuals with these conditions (Gorman, 2003; Weitz et al., 2018).

4.1. Limitations and strengths

Limitations of this study include a non-representative sample, with TEMPO participants having a higher socioeconomic level, being mostly women (66%), and in better health than the general population (Mary-Krause et al., 2021), which may limit generalizability and lead to an underestimation of mental health outcomes. However, the study sample is still heterogeneous and the levels of anxiety and/or depression symptoms are comparable to those in the general population of France (Allchin et al., 2016; Melchior et al., 2014). In addition, there is no evidence that association between LOC and mental health disorders will be different in the general population, as females demonstrated more external locus of control than men (Awaworyi Churchill et al., 2020; Dopelt et al., 2022; Krampe et al., 2021) but also more mental health problems during COVID-19 than men (Metin et al., 2022; Tsukamoto et al., 2021).

Furthermore, the survey could have offered more options for sex status than only "male" or "female" and also asked questions about gender identity as previous research has shown that non-binary or gender diverse participants had elevated levels of adverse mental health conditions during COVID-19 (Gibb et al., 2020; Jarrett et al., 2020; Restar et al., 2021; Wang et al., 2020). There was no scientific statistics about the percentage of people who considered themselves "neither male nor female" in France. In 2015, a systematic review of 12 studies reported a prevalence of 4.6 per 100,000 individuals (Arcelus et al., 2015) and one study performed in Belgium found a prevalence of "gender ambivalence" or non-binary gender among 1.8% natal males and 4.1 natal women (Van Caenegem et al., 2015). But the incidence of gender incongruence is rising (Judge et al., 2014) and is probably higher in the new generation than in TEMPO. Among the 3401 individuals included in TEMPO, only one notified of a sex change (0.03%). Including differential gender instead of sex in our study probably did not change results about the impact of LOC on mental health problems during COVID-19. However, we intend to address these limitations during our next wave of data collection.

Anxiety and/or depression symptoms were self-reported, which could lead to reporting bias (Althubaiti, 2016), but the ASR (Rescorla and Achenbach, 2004) has been validated to evaluate internalizing problems accurately. Furthermore, LOC was assessed using the ICI questionnaire developed a few years ago and which measures all factors of LOC within one scale when contemporary measures, such as the IE-4, use separate subscales to measure separately each type of LOC, internal or external (Nießen et al., 2022). A contemporary measure should have been used to analyze separately each dimension of the LOC.

Moreover, LOC was assessed at time points 8 and 9, while the outcome was assessed at all time points. However, the stability of the LOC score over time is assumed in the literature (Frondel et al., 2021; Hovenkamp-Hermelink et al., 2019; Preuss and Hennecke, 2018) and

given our comparisons of scores between the two time points. TEMPO participants being 40 years old may also explain the stability of LOC, as perceived control is reported to plateau at this age due to major life events such as education completion and major career events being reached (Specht et al., 2013). While our results align with the literature for this age group, it would be interesting to conduct this analysis in other age groups. The choice of the minimum LOC score was another limitation, but sensitivity analysis showed stability in results. In addition, missing data were found to be not missing completely at random (MCAR) but missing at random (MAR), but multiple imputation was undergone to deal with this issue.

Our study has also several strengths. First, the longitudinal design of the study allowed us to obtain real-time data during the first months of the pandemic. Thus, clinically significant symptoms of anxiety and/or depression were assessed by validated instruments during a 13-month follow-up, reflecting the actual mental health of participants compared to a cross-sectional study that would not have been able to do so. Furthermore, history of mental disorders was collected before 2020, as part of the TEMPO cohort, eliminating any potential recall bias, contrary to what may be observed in cross-sectional studies. Second, several confounding factors were included in the analyzes, such as sex and history of clinically significant symptoms of anxiety and/or depression. Measures of loneliness and concern about COVID-19 were also included to control for pandemic-related items. Finally, to our knowledge, this study is one of the first French studies to investigate the LOC.

4.2. Conclusion

Identifying and understanding factors associated with mental health is crucial during the COVID-19 pandemic. This study shows the way a personality trait can alter or protect against mental health decline, with individuals having an external LOC at a higher risk of clinically significant symptoms of anxiety and/or depression than those with an internal LOC, regardless of preexisting symptoms. These findings highlight the importance of implementing Cognitive Behavior Therapies (CBT) to manage mental health. In a health, economic or climate crisis, where lack of control is ubiquitous, public health measures such as positive psychology interventions aiming to foster internal LOC and mental health should be put in place, especially in vulnerable people.

Contributors

M Melchior conceptualized, designed the TEMPO cohort and found funds. M Mary-Krause designed the study. S Wallez coordinated administratively the study, conducted the data collection and the investigations. I Kousignian and M Mary-Krause designed the methodology and statistical analysis protocol. F Eren conducted the statistical analyzes under the supervision of I Kousignian and M Mary-Krause. F Eren wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.jadr.2023.100678](https://doi.org/10.1016/j.jadr.2023.100678).

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