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Perception of stress and cognitive efficiency in older adults with mild and moderate dementia during the COVID-19-related lockdown

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ABSTRACT

Aim: Many studies have been carried out with the aim of understanding the manifold effects of the novel coronavirus (Covid-19) on individuals’ clinical and psychological states. This paper deals with perceived stress (PS) and cognitive efficiency (CE) in older adults with dementia during the first wave of the pandemic. The study also investigated the potential effects of PS and CE on participants’ cognitive functioning. The modulating effect of cognitive reserve (CR) on these variables was also considered, given its well-known role in the onset and evolution of neurodegenerative diseases.

Method: Thirty-eight older adults with mild/moderate dementia (mean age: 81.47 ± 5.05; mean MMSE pre-lockdown: 24.03 ± 3.14) were recruited for this study from March to May [4]. Two questionnaires, the Perceived Stress Scale (PSS) and the FLEI Mental Ability Questionnaire (FLEI), were administered to all participants by telephone every two weeks during lockdown (T1: early April, T2: mid-April, T3: early May). After lockdown, their neuropsychological and psychological profiles were assessed. Linear mixed-effects models were used to investigate changes over time.

Results: The level of PS increased at both Time 2 and Time 3 (f² = 0.10). Cognitive functioning worsened during lockdown, resulting in lower scores at the post-lockdown evaluation (f²s = 0.09 and 0.06 for MMSE and ENB-2, respectively). The decrease in these scores was not associated with either PS or CE. Although the size of these effects was rather small, their clinical relevance is not negligible.

Conclusion: Individuals with dementia seem to have experienced stress (S) during the first-wave of lockdown related to Covid-19. Cognition worsened during the pandemic, in accordance with the neurodegenerative nature of the disease, but it was unrelated to PS and CE.

1. Introduction

The spread of the novel coronavirus SARS-CoV-2 (Covid-19) throughout Italy from February [4] required, as in the rest of the world, the implementation of timely strategies and interventions in order to limit infection and guarantee assistance to as many people as possible. Although other pandemics have occurred throughout history, none has had an impact like that of Covid-19, an event of exceptional magnitude. A meta-analysis by Sepúlveda-Loyola and colleagues [5] drew attention to the consequences of the pandemics for mental health that have occurred so far around the world. The results show an increased risk of developing depression [8], emotional disturbances [30], stress [11], and deflection of mood, irritability or insomnia [19]. Alarminglly, Yip et al. [29] also showed that these disorders are associated with higher suicide rates during pandemics, particularly in older adult populations. These data were corroborated by further studies investigating the psychological effects of lockdown during the SARS, H1N1, Ebola, MERS and Equine Influenza epidemics ([3, 26]). Several studies have shown that people obliged to quarantine generally have a high prevalence of post-traumatic and depressive symptoms, stress and anxiety [11,14–17,19,25].

Increasing amounts of data on the psychological and social
consequences of the Covid-19 pandemic in the general population and on the interventions devised to deal with its effects [24] are becoming available. Particular consideration should be given to older adults, who represent the section of the population with the highest rate of mortality linked to this virus [28].

As also confirmed by Devita and colleagues [10], older individuals constitute an extremely frail population at risk of contagion from Covid-19. Among these individuals, particular attention needs to be focussed on those with neurocognitive disorders, described as “the frailest among the frailest”. Living with the Covid-19 pandemic can, in fact, be extremely difficult for them, as they may not remember to keep an adequately safe distance from other people or may forget to observe the strict health and hygiene guidelines and regulations. Added to these problems, and aggravating the overall picture, are altered behaviours, such as wandering or disinhibition, which are very frequent in individuals suffering from dementia. Due to their pathology, these older individuals may not have acquired a full awareness of the health emergency around them, and because of this they may not have experienced a high level of perceived stress (PS). As a result, they may also have been unaffected by the cognitive burden produced by the pandemic and may not have perceived important changes in their cognitive efficiency (CE) during lockdown.

The aims of this study are twofold. The first is to evaluate the above-mentioned issues by investigating the trend and evolution over time of PS and CE in older individuals with mild/moderate dementia during the first-wave of lockdown. The second is to investigate the potential effects of PS and CE on participants’ cognitive functioning and whether these variables are modulated by cognitive reserve (CR), which is known to play an important role in the onset and evolution of neurodegenerative diseases [27].

2. Materials and methods

Thirty-eight participants were recruited from patients routinely attending the Geriatric Clinic (Department of Medicine - DIMED, University of Padua) and for whom a complete neuropsychological assessment, performed immediately prior to (maximum of 2 months) the spread of Covid-19, was available. The characteristics of participants and their caregivers are reported in Table 1. At the end of lockdown, 29 individuals underwent a follow-up full neuropsychological evaluation.

The participants’ diagnoses, received in the period 2018–2020, ranged from mild to moderate Alzheimer’s Dementia (AD) according to the NINCDS-ADRDA standard clinical diagnostic criteria (mean MMSE pre-lockdown: 24.03 ± 3.14). Participants had to be able to independently provide informed consent to be eligible for the study. All individuals with pre-lockdown MMSE scores <18 were excluded from the study, as were those unable to perform the tests due to advanced cognitive impairment, severe sensory deficits or pathologies of purely psychiatric interest.

Participants were contacted by telephone in April–May 2020 (the Italian lockdown started 9th March 2020 and ended 18th May 2020) and were invited to undergo a telephone interview, during which two questionnaires designed to investigate PS and CE were administered. The level of care provided by family members and participants’ living arrangements in the period before and during lockdown were also established through two ad-hoc semi-structured interviews. The presence of a caregiver or appointed legal guardian (e.g., a support administrator) was always required during telephone interviews.

2.1. Study design and data collection

As illustrated in Fig. 1, each participant underwent a total of three interviews during the Covid-19 lockdown period at intervals of two weeks. At a maximum of two months after the end of lockdown,

Table 1
Descriptive socio-demographic and clinical characteristics of the sample.

| Variables | Participants |
|-----------|--------------|
| Demographic and cognitive characteristics | Total sample (n = 38) | MMSE ≥ 24 (n = 21) | MMSE < 24 (n = 17) |
| Age | 81.47 ± 5.05 | 82.00 ± 4.52 | 80.82 ± 5.71 |
| Gender, Female | 20 (52.6) | 9 (42.9) | 11 (64.7) |
| Education | 10.37 ± 5.20 | 10.09 ± 5.45 | 10.82 ± 5.01 |
| CRiq | 106.89 ± 24.13 | 110.52 ± 24.51 | 102.41 ± 23.60 |
| MMSE pre-lockdown | 24.03 ± 3.14 | 26.30 ± 1.35 | 21.22 ± 2.33 |

| Semi-structured Interview | Before Covid-19 related lockdown | During Covid-19 related lockdown |
|---------------------------|----------------------------------|----------------------------------|
| No one | Spouses | Adult Children | Other Caregiver | Caregiver + Children | Others | No one | Spouses | Adult Children | Other Caregiver | Caregiver + Children | Others |
| Who did/do you live with? | 24 (63.2) | 1 (2.6) | 3 (7.9) | 1 (2.6) | 8 (21.1) | 25 (65.8) | 1 (2.6) | 4 (10.5) |
| Who helped/helps you with shopping? | 21 (53.3) | 8 (21.1) | 2 (5.3) | 2 (5.3) | 1 (2.6) | 9 (23.7) | 23 (60.5) | 2 (5.3) | 3 (7.9) |
| Who oversees the purchase of medicines? | 17 (44.7) | 11 (28.9) | 3 (7.9) | 2 (5.3) | 2 (5.3) | 12 (31.6) | 19 (50) | 3 (7.9) | 2 (5.3) |

Continuous variables are showed as Mean ± Standard Deviation, while frequencies as numerosity (%). CRiq: Cognitive Reserve Index questionnaire; MMSE: Mini-Mental State Examination; M = mean of the scores; SD = Standard Deviation; n = sample size. Other caregiver: nephews, volunteers, social and health workers, etc. Others: home shopping, friends.
participants were called back for a post-lockdown follow-up. Participants were first administered the same questionnaires as in the previous telephone interviews, and secondly were cognitively assessed using the MMSE and the ENB-2 (Esame Neuropsicologico Breve-2 - Brief Neuropsychological Examination-2), which they had also undertaken before the pandemic.

MMSE: Mini-Mental State Examination; ENB-2: Esame Neuropsicologico Breve-2 (Brief Neuropsychological Examination-2); PSS: Perceived Stress Scale; FLEI: FLEI Mental Ability Questionnaire; T = assessment time.

2.2. Measures

Perceived stress (PS; [7]). The Perceived Stress Scale (PSS) is the most frequently used psychological measure to assess perceptions of S [6]. The degree to which the situations in a person’s life are rated as stressful are evaluated by items (n = 10) constructed to capture the level at which respondents perceive their lives as unpredictable, uncontrollable, or overloaded. The scale also contains a series of direct questions about current levels of perceived S. The PSS was designed to be used in samples drawn from the general population with an educational level at least equal to lower middle school. The items and the response alternatives are easy to understand: for each item, respondents are asked to indicate how often they felt a certain way in the last month (‘0 = Never’, ‘4 = Very often’). The PSS scores are obtained by reverse-scoring the responses to the four positively formulated items (items 4, 5, 7 and 8), then adding together the scores for each and every item. A short 4-item scale can be obtained using questions 2, 4, 5 and 10 of the 10 items in the PSS scale. For our study, we adapted the questionnaire to the context by reducing the reference period from “the last 6 months” to “the last 2 weeks”.

There is also a control scale (www.schuhfried.at). For our study, we adapted the questionnaire to the context and the participants by shortening the reference period from “the last 6 months” to “the last 2 weeks” and removing one item deemed not relevant for the intended purposes (i.e., “In important interviews, I have it in mind to address certain points. In the end, I realise I have forgotten to address some points.”) thus reducing the scale from 32 to 31 items.

Mini-Mental State Examination (MMSE; [13, 20]). The MMSE is a widely-used test to assess the presence of cognitive impairment in older people. It takes only 10–15 min to administer, although it is not timed, and provides a reliable measure of cognitive impairment and the progression of dementia. The maximum total score is 30 with a cut-off <24 indicating impairment. Scores are adjusted for age and education.

Brief Neuropsychological Examination -2 (ENB-2; [21]). The ENB-2 is a protocol for neuropsychological assessment. It comprises three parts: (i) neuropsychological history, (ii) neuropsychological interview with the patient and family members, (iii) administration of cognitive tests. It consists of sixteen items for evaluating lexical access and selection, verbal understanding, verbal abstraction, selective attention, divided attention, sustained and alternating attention, executive control functions, short- and long-term memory, working memory, motor skills training, visual recognition and logical reasoning. The ENB-2 allows the patient’s performance to be assessed through both quantitative and qualitative analyses. The scores for individual items are adjusted for age and education and the cut-offs differ according to the respondent’s decade of life and number of years of schooling (and extracurricular courses). A cut-off <8 is considered a “low” level of education, while >8 is considered “high”. The entire protocol takes approximately one hour to administer. Some tests have a time limit, others require the researcher to time the patient while s/he is executing the task, while other tests have no time constraints nor should they be timed.

Cognitive Reserve Index questionnaire (CRIq; [23]). The CRIq is used to assess the level of CR. It consists of 20 items that evaluate educational level (i.e., total numbers of years in education and on other training courses, CR-Education), working activity (i.e., all the occupations held from the age of 18, CR-Working activity) and leisure time (i.e., cognitively stimulating leisure activities, CR-Leisure time). The CR-Total score is calculated as the average of the three sub-scores, standardised and transposed to a scale with a mean of 100 and a standard deviation of 15. In order to reduce possible and involuntary errors (e.g. confabulations or lack of memory due to the clinical characteristics of the sample itself), the CRIq was administered to caregivers, as allowed by the questionnaire instructions [23].

Informed consent was given by all participants when collecting their clinical data. The protocol was submitted to the local ethic committee (protocol N. 15,228).

Fig. 1. Study design.
2.3. Statistical analyses

A linear mixed-effects model (LMM) approach was used to investigate the changes over time in the variables of interest, namely the level of perceived S (PSS), the level of perceived CE (FLEI), and cognitive functioning as indicated by the MMSE and ENB-2 scores. LMMs are used to analyze the inter-dependencies among the observations in a repeated-measures study, such as the present one, which increases the reliability of the results and reduces the probability of committing a type I error. Moreover, LMMs can easily handle missing data, a problem with repeated-measure studies, without discarding the entire set of observations in which the missing data are observed. In a typical repeated-measure analysis of variance (ANOVA), missing data are dealt with by listwise deletion (i.e., respondents with incomplete observations are discarded entirely from the analysis), which comes at a very high price, especially in the case of small sample sizes, as in the present study. LMMs, on the other hand, can retain all the observations with a valid value, even at only one time point. To estimate the mean on which comparisons are based, LMMs use the data from respondents with complete observations at all time points and from respondents whose data are complete only at a specific time point. This avoids completely eliminating a respondent with missing observations at only one of the time points.

Four models were specified to investigate the effects of time, the level of CR, and their interaction on the level of perceived S (PSS). Four models were also created to investigate the effects of the same variables on the level of perceived CE (FLEI). In all models, respondents were specified as random intercepts to account for the within-respondents/between-assessments variability over time. Given that there was only one observation per respondent at each assessment time (i.e., the PSS or FLEI score), it was not possible to specify the random slopes of the subjects at each time point, a specification that would have provided information on the adjustment of each individual throughout time. The first model (Model 1) included only the fixed intercept and the random intercepts of the respondents. In the second model, assessment time was added as a fixed effect (Model 2). The CR score was added in the third model as an additive effect, hence only the main effect of CR on the PSS or FLEI score was investigated (Model 3). Finally, in the fourth model, the effect of the interaction between assessment time and CR was added (Model 4).

A similar approach was taken to investigate the pre- and post-lockdown changes in cognitive functioning (ENB-2 and MMSE). The effects of the level of perceived S and the level of perceived CE on cognitive functioning were also investigated. The levels of perceived S and CE were considered at each of the three assessment times in terms of their interaction with the pre- and post-lockdown assessment. This resulted in five models being specified for investigating the changes in cognitive functioning as indicated by MMSE scores, and five models for investigating the changes in cognitive functioning as indicated by ENB-2 scores. The first model (Model 1) included only the intercept, representing the expected MMSE or ENB-2 score. The second and third models also included the main effects of time (Model 2), and of perceived S and perceived CE (Model 3). The effects of the interaction between Time T2 and the levels of perceived S and CE (Model 4) and the effects of the interaction between Time T3 and the levels of perceived S and CE (Model 5) were added to the fourth and fifth models. To test the significance of each of the variables of interest (i.e., the time of assessment, the level of S as indicated by the CR in score, and their interaction) on the perceived level of S (PSS score) and on CE (FLEI score), a constrained model and a full model were compared and a Kenward-Roger’s adjusted F-test [18] was performed, as illustrated in Faraway [12]. If the F statistics resulting from the comparison between the constrained model (i.e., without the effect of interest) and the full model (i.e., including the effect of interest) are significant, the addition of the new variable, and hence its contribution in explaining the dependent variable, can be considered significant. The same approach was taken to test the significance of the effects of the time point and the perceived levels of S and CE on cognitive functioning (i.e., the MMSE and ENB-2 scores).

The marginal $R^2$ of the models (i.e., the proportion of variance explained by the fixed effects) were computed according to Nakagawa et al. [22]. The $f^2$ statistic was computed as an effect size measure for the fixed effects [1]. This statistic expresses the proportion of variance explained by the model including the fixed effect(s) of interest ($R_{\text{fixed}}^2$) and the proportion of variance explained by the model without the fixed effect(s) of interest ($R^2$). Values of $f^2$ close to 0.02, 0.15, and 0.35 denote small, medium, and large effect sizes, respectively [6].

3. Results

The main descriptive characteristics of the sample are shown below (see Table 1).

As emerged from the semi-structured interview, some differences can be observed between and after the Covid-19 related lockdown in some specific domain of life and daily routine. In particular, before the lockdown, the majority of participants were mainly helped by their spouses for shopping and purchase of medicines during lockdown, instead, a more central role was given to the adult children that supported our participants in these tasks more than other caregivers, spouses included.

Furthermore, and more predictably because of the social restrictions associated with the lockdown, physical activity and social contacts significantly decreased during the lockdown.

Thirty-eight participants (F = 52.63%, age = 81.47 ± 5.05 years, range = 70–91 years) completed PSS and FLEI data at all three assessments carried out during lockdown. Analyses of the trends in these variables were therefore performed on the entire data set from these 38 respondents.

The means and standard deviations of the PSS, FLEI, MMSE and ENB-2 scores at each assessment time are reported in Table 2.

Nine respondents with invalid data at both the pre- and post-lockdown ENB-2 assessments had to be discarded from the analysis. All the remaining 29 respondents (F = 58.62%, age = 81.21 ± 5.30 years, range = 70–91 years) had at least one valid observation at either the pre-lockdown or the post-lockdown ENB-2 assessment, and at least one valid observation at either the pre- or the post-lockdown MMSE assessment. The results of the effects of time and CR on the levels of perceived S as assessed by the PSS are reported in Table 3.

The first assessment during lockdown (T1) is described by the intercept in each model. As such, T1 is the reference level of the time variable against which the other two levels (i.e., T2 and T3) are compared. The Kenward-Roger’s F-test revealed the significance of the main effects of both the time of assessment and the level of CR on the level of PS, although their effect size was small ($f^2 = 0.10$). Specifically, the level of perceived S increased at both T2 and T3, but slightly more so at T2 than at T3. CR positively predicted the level of perceived S throughout time, such that higher levels of CR tended to be associated

| Time   | PSS       | FLEI      |
|--------|-----------|-----------|
| T1     | 11.29 ± 7.18 | 77.13 ± 17.55 |
| T2     | 13.95 ± 8.57  | 75.47 ± 12.82 |
| T3     | 13.79 ± 8.67  | 75.26 ± 14.20 |

Notes: T1: first assessment during lockdown; T2: second assessment during lockdown; T3: third assessment during lockdown; PSS: Perceived Stress Scale; FLEI: FLEI Mental Ability Questionnaire; MMSE: Mini-Mental State Examination; ENB-2: Exame Neuropsicologico Breve-2 [Brief Neuropsychological Examination-2].
with higher levels of S, regardless of the time of assessment. Further corroborating this result, both the Kenward-Roger’s test and the entropy indices (AIC and BIC, the smaller the better) favoured the model without the interaction term between CR and time of assessment. The influence of CR on the level of perceived S did not change as a function of time.

The results of the effects of time and CR on the level of perceived CE as assessed by FLEI scores are reported in Table 4.

Both the Kenward-Roger’s test and the entropy indices revealed the absence of effects of time, CR and their interaction on the level of perceived CE. Nonetheless, the trends in the FLEI scores indicated a decrease in the level of perceived CE (i.e., the respondents’ level of perceived CE was higher as time passed during lockdown).

The results of the trends in cognitive functioning pre- and post-lockdown as indicated by MMSE scores are reported in Table 5.

The intercept in all models represents the expected pre-lockdown average MMSE score. Only time of assessment had a significant effect on MMSE scores, although its effect size was small ($f^2 = 0.09$). Regardless of the specific time at which they were administered, FLEI and PSS had no effect on MMSE scores. No effects of the interaction between either FLEI or PSS and the time of assessment on MMSE scores was found.

The results of the trends in cognitive functioning pre- and post-lockdown as indicated by ENB-2 scores are reported in Table 6.

4. Discussion

This study investigated the stress experienced by older individuals with mild/moderate dementia during the first-wave of lockdown and their perceptions of cognitive efficiency in that period. As shown in the Results section, the perceived level of stress increased during lockdown, at both T2 and T3. The highest increase was observed at T2, the assessment time coinciding with the peak of the pandemic (i.e., around mid-April). Despite a lower awareness of

Table 3  
Changes in PSS scores throughout lockdown.

|       | Model 1 | Model 2 | Model 3 | Model 4 |
|-------|---------|---------|---------|---------|
|       | B (SE)  | B (SE)  | B (SE)  | B (SE)  |
| Intercept | 13.01 (1.19) | 11.29 (1.31) | 11.29 (1.25) | 11.29 (1.24) |
| T2     | 2.66 (0.95) | 2.66 (0.95) | 2.66 (0.93) | 2.66 (0.93) |
| T3     | 2.50 (0.95) | 2.50 (0.95) | 2.50 (0.93) | 2.50 (0.93) |
| CRIq   | 0.10 (0.05) | 0.06 (0.05) | 0.06 (0.05) | 0.06 (0.05) |
| T2 × CRIq | 0.08 (0.04) | 0.05 (0.04) | 0.05 (0.04) | 0.05 (0.04) |
| T3 × CRIq | 0.06 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) |
| Observations (n) | 114 | 114 | 114 | 114 |

Notes: CRIq: Cognitive Reserve Index questionnaire; T1: first assessment during lockdown; T2: second assessment during lockdown; T3: third assessment during lockdown; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; $R^2$: Proportion of variance explained by the fixed effects [22]; $f^2$: Effect size measure expressing the proportion of variance explained by the fixed effect relative to the proportion of outcome variance unexplained [1].

Table 4  
Changes in FLEI scores throughout lockdown.

|       | Model 1 | Model 2 | Model 3 | Model 4 |
|-------|---------|---------|---------|---------|
|       | B (SE)  | B (SE)  | B (SE)  | B (SE)  |
| Intercept | 75.96 (2.23) | 77.13 (2.40) | 77.13 (2.37) | 77.13 (2.36) |
| T2     | –1.66 (1.55) | –1.66 (1.55) | –1.66 (1.55) | –1.66 (1.55) |
| T3     | –1.87 (1.55) | –1.87 (1.55) | –1.87 (1.55) | –1.87 (1.55) |
| CRIq   | 0.10 (0.09) | 0.18 (0.10) | 0.18 (0.10) | 0.18 (0.10) |
| T2 × CRIq | −0.11 (0.06) | −0.13 (0.06) | −0.13 (0.06) | −0.13 (0.06) |
| T3 × CRIq | −0.13 (0.06) | −0.13 (0.06) | −0.13 (0.06) | −0.13 (0.06) |
| Observations (n) | 114 | 114 | 114 | 114 |

Notes: CRIq: Cognitive Reserve Index questionnaire; T1: first assessment during lockdown; T2: second assessment during lockdown; T3: third assessment during lockdown; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; $R^2$: Proportion of variance explained by the fixed effects [22]; $f^2$: Effect size measure expressing the proportion of variance explained by the fixed effect relative to the proportion of outcome variance unexplained [1].

Table 5  
Pre- and post-lockdown changes in MMSE scores.

|       | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|-------|---------|---------|---------|---------|---------|
|       | B (SE)  | B (SE)  | B (SE)  | B (SE)  | B (SE)  |
| Intercept | 23.19 (0.64) | 24.18 (0.67) | 24.18 (0.67) | 24.18 (0.67) | 24.18 (0.67) |
| Post   | –1.99 (0.42) | –1.99 (0.39) | –1.99 (0.42) | –1.99 (0.42) | –1.99 (0.42) |
| PSS1 (T1) | 0.07 (0.10) | 0.07 (0.10) | 0.07 (0.10) | 0.07 (0.10) | 0.07 (0.10) |
| FLEI (T1) | 0.02 (0.05) | 0.02 (0.05) | 0.02 (0.05) | 0.02 (0.05) | 0.02 (0.05) |
| Post × PSS (T1) | 0.02 (0.05) | 0.02 (0.05) | 0.02 (0.05) | 0.02 (0.05) | 0.02 (0.05) |
| Post × FLEI (T1) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) |
| PSS (T2) | 0.03 (0.09) | 0.03 (0.09) | 0.03 (0.09) | 0.03 (0.09) | 0.03 (0.09) |
| FLEI (T2) | 0.05 (0.05) | 0.05 (0.05) | 0.05 (0.05) | 0.05 (0.05) | 0.05 (0.05) |
| Post × PSS (T2) | 0.08 (0.06) | 0.08 (0.06) | 0.08 (0.06) | 0.08 (0.06) | 0.08 (0.06) |
| Post × FLEI (T2) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) |
| PSS (T3) | 0.06 (0.09) | 0.06 (0.09) | 0.06 (0.09) | 0.06 (0.09) | 0.06 (0.09) |
| FLEI (T3) | 0.05 (0.05) | 0.05 (0.05) | 0.05 (0.05) | 0.05 (0.05) | 0.05 (0.05) |
| Post × PSS (T3) | 0.08 (0.06) | 0.08 (0.06) | 0.08 (0.06) | 0.08 (0.06) | 0.08 (0.06) |
| Post × FLEI (T3) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) | 0.03 (0.03) |
| Observations (n) | 58 | 58 | 58 | 58 | 58 |

Notes: PSS: Perceived S scale; FLEI: FLEI Mental Ability Questionnaire; Post: Post-lockdown assessment; T1: first assessment during lockdown; T2: second assessment during lockdown; T3: third assessment during lockdown; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; $R^2$: Proportion of variance explained by the fixed effects [22]; $f^2$: Effect size measure expressing the proportion of variance explained by the fixed effect relative to the proportion of outcome variance unexplained [1].
further corroborates this supposition. Regardless of the time of assessment, the higher the level of cognitive reserve, the higher the level of cognitive functioning worsened during lockdown, and this deterioration was not associated with either the perceived level of stress or perceived cognitive efficiency. Although the effects sizes observed in the present study were rather small, their clinical relevance is not negligible, also in light of other studies in literature that report a worsening of cognitive and behavioural symptoms like memory deficits, apathy/aggressivity and stress in individuals with dementia [5].

Interestingly, FLEI scores exhibited a decreasing trend, which indicates a higher level of perceived cognitive efficiency at the end of lockdown than that at the beginning (higher scores correspond to a lower perceived cognitive efficiency while lower scores correspond to a higher level of cognitive efficiency). However, this result was not statistically significant and should therefore be treated with caution. The data collected qualitatively contain additional information about participants’ routines before and during the pandemic and reveal that the majority of them were assisted in their daily activities (e.g., in purchasing medicines and necessities) from close caregivers (mainly sons or daughters). According to other studies (i.e., [2]), it could be hypothesised that caregivers also perceived a general malaise due to lockdown (for example, stress, anxiety and depression), emphasizing, in turn and indirectly, the stress perceived by individuals with dementia. Furthermore, the ‘negative’ influence of the caregivers’ burden could induce (or exacerbate) behavioural and psychological symptoms in this clinical population [4]. In this way, one may argue that the PS observed in our sample was increased also by the PS expressed by caregivers. However, the “stay-at-home” directives for reducing the risk of contagion prevented caregivers from having contact with the study participants, who therefore had to fend for themselves day by day. We may hypothesise that in a context such as that of lockdown, individuals with dementia did indeed experience stress but that the circumstances gave them the chance to “roll up their sleeves”, which, in turn, gave them a greater feeling of efficiency in their everyday lives, including at the cognitive level.

Notwithstanding these last points, a significant cognitive decline emerged at the post-lockdown neuropsychological follow-up, in line with the neurodegenerative nature of the disease, but it was not associated with PS and CE.

4.1. Limitations

Some limitations must certainly be acknowledged. Firstly, the small sample size may weaken the generalisability of the results. In addition, we were unable to conduct a post-lockdown follow-up. Secondly, baseline PS and CE data (i.e., before Covid-19) for the population studied were not available. Furthermore, we had not investigated the affective component that probably had a significant influence on the PS and CE of these individuals. If additional data on these variables were collected at the end of the pandemic they might be helpful in clarifying the participants’ routine self-evaluations. Lastly, there was no control group. Given these important limitations, the results reported here should be considered preliminary and treated with caution.

5. Conclusions

Individuals with dementia seem to have experienced stress during the first-wave of lockdown related to Covid-19. This result suggests that, in particular situations, these individuals may still have consciousness and perceive stress even if not everyone has consciousness of the events happening around them. Consequently, it is reasonable to think that the clinicians could attend these persons with ad hoc ‘remote’ interventions (because of social distancing) to calm down the Behavioural and Psychological Symptoms of Dementia (BPSD) or cognitive impairment (for example, through psycho-educational support for caregivers or the Cognitive Stimulation Therapy; [10]). These individuals’ level of

surrounding events and the fragile cognition which characterises people with neurocognitive disorders [9], these results suggest that older individuals with mild/moderate dementia are still able to perceive events taking place around them, hence causing them to experience stress. Since the major peak of psychological malaise coincided exactly with the pandemic reaching its most critical point, we may speculate that the impact of Covid-19 was general and pervasive and also affected people with neurodegenerative diseases.

The significant association between cognitive reserve and stress further corroborates this supposition. Regardless of the time of assessment, the higher the level of cognitive reserve, the higher the level of perceived stress. As such, we may hypothesise that individuals with higher levels of cognitive reserve also have more cognitive resources allowing them a better understanding of the world and the circumstances around them. Taken together, the results of the MMSE and the ENB-2 indicate that cognitive function worsened during lockdown, and this deterioration was not associated with either the perceived level of stress or perceived cognitive efficiency. Although the effects sizes observed in the present study were rather small, their clinical relevance is not negligible, also in light of other studies in literature that report a worsening of cognitive and behavioural symptoms like memory deficits, apathy/aggressivity and stress in individuals with dementia [5].

Interestingly, FLEI scores exhibited a decreasing trend, which indicates a higher level of perceived cognitive efficiency at the end of lockdown than that at the beginning (higher scores correspond to a lower perceived cognitive efficiency while lower scores correspond to a higher level of cognitive efficiency). However, this result was not statistically significant and should therefore be treated with caution. The data collected qualitatively contain additional information about participants’ routines before and during the pandemic and reveal that the majority of them were assisted in their daily activities (e.g., in purchasing medicines and necessities) from close caregivers (mainly sons or daughters). According to other studies (i.e., [2]), it could be hypothesised that caregivers also perceived a general malaise due to lockdown (for example, stress, anxiety and depression), emphasizing, in turn and indirectly, the stress perceived by individuals with dementia. Furthermore, the ‘negative’ influence of the caregivers’ burden could induce (or exacerbate) behavioural and psychological symptoms in this clinical population [4]. In this way, one may argue that the PS observed in our sample was increased also by the PS expressed by caregivers. However, the “stay-at-home” directives for reducing the risk of contagion prevented caregivers from having contact with the study participants, who therefore had to fend for themselves day by day. We may hypothesise that in a context such as that of lockdown, individuals with dementia did indeed experience stress but that the circumstances gave them the chance to “roll up their sleeves”, which, in turn, gave them a greater feeling of efficiency in their everyday lives, including at the cognitive level.

Notwithstanding these last points, a significant cognitive decline emerged at the post-lockdown neuropsychological follow-up, in line with the neurodegenerative nature of the disease, but it was not associated with PS and CE.

Table 6

| Table 6 | Pre- and post-lockdown changes in ENB-2 scores. |
|---------|-----------------------------------------------|
|         | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|         | B (SE)  | B (SE)  | B (SE)  | B (SE)  | B (SE)  |
| Intercept | 50.21   | 53.76   | 53.99   | 53.91   | 54.15   |
|          | (2.05)  | (2.26)  | (2.38)  | (2.27)  | (2.26)  |
| Post     | -6.06   | -6.29   | -6.21   | -6.45   |           |
|          | (1.63)  | (1.77)  | (1.74)  | (1.69)  |           |
| PSS (T1) | -0.02   |           |           |           |           |
|          | (0.36)  |           |           |           |           |
| FLEI (T1)| 0.03    |           |           |           |           |
|          | (0.16)  |           |           |           |           |
| Post × PSS (T1) | -0.06 |           |           |           |           |
|          | (0.26)  |           |           |           |           |
| Post × FLEI (T1)| -0.05 |           |           |           |           |
|          | (0.12)  |           |           |           |           |
| PSS (T2) | 0.48    |           |           |           |           |
|          | (0.29)  |           |           |           |           |
| FLEI (T2)| -0.13   |           |           |           |           |
|          | (0.20)  |           |           |           |           |
| Post × PSS (T2)| -0.08 |           |           |           |           |
|          | (0.22)  |           |           |           |           |
| Post × FLEI (T2)| -0.07 |           |           |           |           |
|          | (0.16)  |           |           |           |           |
| PSS (T3) | 0.43    |           |           |           |           |
|          | (0.31)  |           |           |           |           |
| FLEI (T3)| -0.12   |           |           |           |           |
|          | (0.18)  |           |           |           |           |
| Post × PSS (T3)| -0.14 |           |           |           |           |
|          | (0.22)  |           |           |           |           |
| Post × FLEI (T3)| -0.12 |           |           |           |           |
|          | (0.14)  |           |           |           |           |
| Observations | 52 | 52 | 52 | 52 | 52 |
| Respondents |       |       |       |       |       |
| Log Likelihood | -193.94 | -186.86 | -189.77 | -188.10 | -187.83 |
| AIC | 393.88 | 381.72 | 395.54 | 392.20 | 391.67 |
| BIC | 399.73 | 389.52 | 411.15 | 407.81 | 407.28 |
| Forward | F(1,23) = F(4,33) = F(4,33) = F(4,33) = |
| Roger’s | 13.65** | 0.09 | 0.89 | 1.02 |
| F-test | 0.00 | 0.06 | 0.06 | 0.14 | 0.15 |
| ρ² | 0.06 | 0.00 | 0.09 | 0.01 |

Notes: ***: p < 0.001; *: p < 0.05; PSS: Perceived Stress scale; FLEI: FLEI Mental Ability Questionnaire; Post: Post-lockdown assessment; T2: second assessment during lockdown; T3: third assessment during lockdown; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; R²: Proportion of variance explained by the fixed effects [23]; ρ²: Effect size measure expressing the proportion of variance explained by the fixed effect relative to the proportion of outcome variance unexplained [1].

The ENB-2 scores showed the same trend as the MMSE scores. Specifically, time of assessment was the only significant effect, although its effect size was small (ρ² = 0.06). Post-lockdown scores tended to be lower than pre-lockdown scores, indicating a decrease in the cognitive functioning of respondents after lockdown. Neither the perceived levels of S nor of CE nor their interaction with time had an effect on the respondents’ cognitive functioning.
perceived stress was significantly associated with their cognitive reserve, while their cognitive functioning was lower after lockdown than in the pre-lockdown period. This worsening seems to be due to the neurodegenerative nature of the disorder as the cognitive functioning scores were not associated with perceived stress nor with perceived cognitive efficiency. Nevertheless, we did not know how much the affective component influenced our participants, so these data should be taken cautiously.

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Statement of human and animal rights

This study was carried out with respect for human and animal rights.

Informed consent

Informed consent to collect their clinical data was given by all patient.

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