Associations between pleasant events, activity restriction, stressors, and blood pressure in caregivers of persons with dementia

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Abstract

Objectives: Caring for a relative with dementia is associated with adverse consequences for cardiovascular health. Cognitive and behavioral factors, such as high perceived activity restriction and low frequency of pleasant events have been found to be associated with higher levels of blood pressure, but the role these variables play in the stress and coping process remains understudied. The objective of this study is to analyze the associations between behavioral and psychological symptoms of dementia, activity restriction, frequency of pleasant events, and mean arterial pressure.

Design: Face-to-face interviews and cross-sectional analyses.

Setting: Social services, healthcare centers, and adult day services of Comunidad de Madrid, Spain.

Participants: One hundred and two family caregivers of a spouse or parent with dementia.

Measurements: Apart from various sociodemographic and health-related variables, behavioral and psychological symptoms of dementia, activity restriction, and frequency of leisure activities were assessed. In addition, measurement of blood pressure levels was conducted through an electronic sphygmomanometer.

Results: The obtained model suggests that there is a significant indirect association between behavioral and psychological symptoms of dementia and mean arterial pressure through activity restriction and frequency of pleasant events.

Conclusions: The findings of this study provide preliminary support for a potential indirect effect between behavioral and psychological symptoms of dementia and blood pressure, through the effects of behavioral and psychological symptoms of dementia on the caregivers’ levels of activity restriction and frequency of pleasant activities. Our manuscript provides additional support for the pleasant events and activity restriction model (Mausbach et al., 2011; Chattillion et al., 2013), by highlighting the importance of considering caregiving stressors as a source of caregivers’ activity restriction in the theoretical framework of the model.

Key words: behavioral and psychological symptoms of dementia, carers

Introduction

Caring for a relative with dementia is a stressful experience that has been associated with negative consequences for caregivers’ physical health such as higher levels of blood pressure (Kim and Knight, 2008), greater risk of developing hypertension (Shaw et al., 1999), and a twofold increased risk of developing cardiovascular disease (Capistrant et al., 2012). Among the stressors that caregivers of persons with dementia may have to face, a higher frequency of behavioral and psychological symptoms of dementia displayed by the relatives associated with a higher level of distress (van der Lee, 2014) and worse physical health (Pinquart and Sörensen, 2007).
Different models have been proposed to explain the association of caregiving stressors with negative physical health consequences for caregivers, among which the stress and coping model has received strong empirical support (Haley et al., 1987; Knight and Sayegh, 2010). This model, based on Lazarus and Folkman's original work (Lazarus and Folkman, 1984), proposes that the association between caregiving stressors and health outcomes is not direct, but modulated through other variables, most notably caregivers' resources such as coping strategies (see Figure 1). As shown in previous studies (e.g., Kim et al., 2007), these resources modulate the effects of stress on caregivers' health outcomes (e.g., blood pressure).

In addition to coping strategies, several sociodemographic factors and health habits have also been considered as key covariates and important predictors of caregivers' physical health (Kiecolt-Glaser et al., 2002; Vitaliano et al., 2002). Specifically, risk factors such as age (Shaw et al., 2003), gender (Atienza et al., 2001), body mass index (Mausbach et al., 2017), and physical exercise (von Känel et al., 2011) are among those most strongly associated with cardiovascular risk. For understanding the role of these predictors in the caregiving stress process, Vitaliano et al. (2002) developed the path model of chronic stress, the metabolic syndrome, and coronary heart disease. In this model, caregiver distress is believed to be a path to developing metabolic syndrome, which in turn raises the risk of the onset of chronic heart disease. This model also highlights the influence on caregivers' health of chronic stressors and caregivers' personal resources (e.g., coping). What the model adds to the stress and coping model is the proposal that this chronic stress may influence health habits (e.g., physical exercise), and at the same time, these health habits can affect the metabolic syndrome (e.g., blood pressure levels, see Figure 1), which could finally determine the appearance of coronary artery disease.

Potential pathways by which caregiver stress and resource variables affect caregivers' blood pressure are underexplored. Low engagement in pleasant leisure activities is one behavioral resource variable that has been associated with increased blood pressure in caregivers of persons with dementia (Chattillion et al., 2013; Mausbach et al., 2017). Pleasant activities have been described as those activities, which individuals consider to be rewarding, reinforced by others, or even activities that can act as reinforcers for other behaviors (Lewinsohn, 1975). In addition, several studies have shown a negative impact of caregiver stress on caregivers' engagement in leisure activities (e.g., Losada et al., 2010).

The importance of identifying psychological variables that serve as potential barriers to engaging in pleasant activities has been noted (Ross and Carroll, 2017). For this purpose, Mausbach and colleagues (2011) developed the pleasant events and activity restriction model, derived from the pleasant events (Lewinsohn, 1973) and activity restriction (Williamson and Schulz, 1992) models, to highlight the importance of considering both cognitive factors

Figure 1. Hypothesized model for this study, by combining variables extracted from the stress and coping model (Knight and Sayegh, 2010), the pleasant events and activity restriction model (Mausbach et al., 2011, Chattillion et al., 2013), and the path model of chronic stress, the metabolic syndrome, and coronary heart disease (Vitaliano et al., 2002).
(i.e., perceived activity restriction) and behavioral factors (engagement in pleasant activities) for a better understanding of dementia family caregivers’ depressive symptoms. While these concepts are similar, engagement in pleasant events represents active engagement in social or leisure activities, whereas activity restriction represents perceived restriction in one’s ability to pursue leisure (Williamson and Shaffer, 2000).

While increase in pleasant events have been related to decrease in markers of cardiovascular risk in caregivers, including interleukin-6 (Moore et al., 2013), other studies have shown an association between increased activity restriction and cardiovascular risk (Ho et al., 2013). The pleasant events and activity restriction model proposes that the consideration of both frequency of pleasant events and activity restriction contributes to a better understanding of consequences for caregivers’ physical health than the consideration of each of these variables alone. Mausbach et al. (2011) found support for this theoretical model by showing that a combination of low engagement in pleasant events and high levels of activity restriction was associated with greater vulnerability to negative health outcomes (e.g., blood pressure) and a higher use of maladaptive coping strategies as compared with caregivers showing different profiles (e.g., low engagement in pleasant activities and low activity restriction; Chattillon et al., 2013).

However, despite direct support for the pleasant events and activity restriction model’s links to a higher use of maladaptive coping strategies and cardiovascular health, this model has never been analyzed in the framework of a stress process model, making it unclear how stress, activity restriction, pleasant events, and physical health outcomes are related. Caregiving stressors may be associated with increased activity restriction (Nieboer et al., 1998), and the perception of this limitation may reduce the frequency of caregiver engagement in pleasant activities, with an adverse effect on caregivers’ physical health. However, this has not been tested yet.

As shown in Figure 1, the pleasant events and activity restriction model is compatible with the stress and coping model adapted to caregiving (Knight and Sayegh, 2010) and path model of chronic stress, the metabolic syndrome, and coronary heart disease (Vitaliano et al., 2002). Drawing upon the stress and coping model, high frequency of pleasant events and reduced activity restriction may be acting as resources that may modulate the effects of caregiving stressors on caregivers’ physical health (Chattillon et al., 2013). However, previous research has not yet analyzed the joint role of engagement in pleasant events and activity restriction in the association between stressors and caregivers’ cardiovascular health. Advancing our knowledge of the role of pleasant events and activity restriction in this association can have important clinical implications. Targeting activity restriction and/or engagement in pleasant events through psychological interventions on highly stressed caregivers may be especially helpful for buffering the impact of stress on caregivers’ cardiovascular health.

In summary, previous studies have shown the negative impact stressors have on caregivers’ reported frequency of pleasant events and on caregivers’ physical health. Previous research in family caregivers of persons with dementia shows the negative associations between frequency of pleasant events and activity restriction on cardiovascular health. As a novelty, this study aims to fill an important gap in the literature, which is the joint analysis of the abovementioned variables in the context of the caregiving stress and coping model. Specifically, this study aims to explore (a) the role of activity restriction in the relationship between stressors (frequency of and reaction to behavioral and psychological symptoms) and frequency of pleasant events and (b) how activity restriction and frequency of pleasant events contribute to the understanding of the association between caregiving stressors and blood pressure. We specifically drew upon the stress and coping model (Knight and Sayegh, 2010) and propose a stress process model incorporating caregiving stressors to the variables considered in the pleasant events and activity restriction model, while also adding health behavior variables as suggested by Vitaliano’s path model of chronic stress in caregivers of persons with dementia (Vitaliano et al., 2002). We hypothesized that (1) higher levels of behavioral and psychological symptoms of dementia will be associated with increased activity restriction and reduced engagement in pleasant events and (2) there will be an indirect association of behavioral and psychological symptoms of dementia with blood pressure explained by the direct association between behavioral and psychological symptoms of dementia and caregivers’ higher activity restriction and lower engagement in pleasant events.

**Methods**

**Participants and procedure**

Participants of this study were family caregivers caring for a relative who has been diagnosed with any kind of dementia by a physician. These potential participants were contacted through social services, healthcare centers, and adult day services. Those caregivers who wished to participate were scheduled
at their contact centers for a face-to-face interview with a psychologist lasting approximately 90 min and signed an informed consent. No economic compensation was offered for their participation. All participants received a brochure that included useful information about caregiving and the dementias (e.g. how to manage disruptive behaviors). Inclusion criteria were: (a) being the main caregiver of a parent or spouse with dementia; (b) being 18 years or older; (c) devoting at least one daily hour to caregiving tasks; and (d) having provided care for at least 3 consecutive months prior to enrollment. Consistent with previous studies (Harmell et al., 2011; von Känel et al., 2011, von Känel et al., 2012), caregivers with severe hypertension (>200/120 mmHg) were excluded from the study to avoid major effects on study outcomes when including people with overt cardiovascular problems. Of the 123 caregivers that were screened for potential participation in this study, 8 rejected participation and were not interviewed, 9 were interviewed but were not caring for a parent or a spouse with dementia, and 4 did not meet other inclusion criteria. The final sample was composed of 102 family caregivers of a parent or spouse with dementia. The Ethics Committee of Rey Juan Carlos University and the Spanish Ministry of Economy and Competitiveness approved the study protocol.

**Measures and analyses**

**Demographic data and health characteristics**

Collected demographic information included self-reported caregiver’s age, gender, kinship with the care recipient, care recipient diagnosis, daily hours devoted to care, and months since being a caregiver. Body mass index (computed as the ratio between participants’ self-reported weight in kilograms and the square of their height in meters) was also collected as an indicator of health habits. Finally, the number of days performing physical exercise per week was collected as a health habit indicator with a single item (i.e. “During how many days per week do you usually conduct physical exercise activities (e.g. doing some kind of sport, dancing, etc.)?”), with the following possible answers: 0 (“not a single day”), 1 (1 or 2 days per week), 2 (2 or 3 days per week), 3 (4 or 5 days per week), and 4 (6 or 7 days per week), similar to what has been done in previous studies regarding cardiovascular health in caregivers of persons with dementia (von Känel et al., 2006, 2010).

**Blood pressure**

An electronic sphygmomanometer OMROM M7 (HEM-780-E) was used to measure resting blood pressure. Specifically, three systolic and diastolic blood pressure measures were taken throughout the individual interview, which lasted approximately one and a half hour. The first blood pressure measure was tested at the beginning of the interview (after the informed consent was signed), the second blood pressure measure was taken in the middle of the interview (approximately 45 min after the first assessment), and the third blood pressure assessment was conducted approximately one and a half hours after the first assessment (at the end of the interview). Mean arterial pressure was then calculated for each of the three blood pressure assessments with the following formula: (Systolic Blood Pressure + 2*Diastolic Blood Pressure)/3.

**Cognitive status of the care-recipient**

The Global Deterioration Scale (Reisberg et al., 1982) was used. This is a 7-point rating instrument, in which each of them corresponds to different levels of cognitive and functional impairment in healthy controls and patients with dementia. The corresponding levels are: 1 (“No cognitive decline”); 2 (“Very mild cognitive decline”); 3 (“Mild cognitive decline”); 4 (“Moderate cognitive decline”); 5 (“Moderately severe cognitive decline”); 6 (“Severe cognitive decline”); and 7 (“Very severe cognitive decline”).

**Frequency of behavioral and psychological symptoms of dementia**

The Spanish validation (Nogales-González et al., 2015) of the frequency scale from the Revised Memory and Behavior Problems Checklist (Teri et al., 1992) was used. Twenty-four items reflecting behavioral, depressive, or memory problems in persons with dementia (e.g. “destroying property”) are rated on a 5-point scale between 0 (“never occurs”) and 4 (“occurs daily or more often”), with all items summed to create an overall score. Cronbach’s alpha for this scale was .83 in the present study.

**Reaction to behavioral and psychological symptoms of dementia**

The Spanish validation (Nogales-González et al., 2015) of the reaction scale from the Revised Memory and Behavior Problems Checklist (Teri et al., 1992) was used. Twenty-four items (e.g. “destroying property”) are rated on a 5-point scale between 0 (“it doesn’t bother or upset me at all”) and 4 (“it bothers or upsets me extremely”) and summed to create an overall reaction score. A score of 0 was assigned to those items that never occur, as reported in the frequency scale. Cronbach’s alpha for this scale was .91 in the present study.
FREQUENCY OF PLEASANT EVENTS
This variable was measured through the Pleasant Events Scale – AD (Logsdon and Teri, 1997), the same measure that was used in the development of the pleasant events and activity restriction model (Mausbach et al., 2011). Participants were asked to rate how often they participated in 20 different activities (e.g. “go shopping”), and were rated on a 3-point scale ranging between 0 (“hasn’t done it in the past month”) and 2 (“has done it often (more than 7 times) in the past month”). A total score was created by summing the 20 items. Cronbach’s alpha for this scale was .73 in the present study.

ACTIVITY RESTRICTION
This variable was measured through the Activity Restriction Scale (Williamson and Schulz, 1992), the same measure that was used in the development of the pleasant events and activity restriction model (Mausbach et al., 2011). This 9-item scale measures how restricted participants felt in doing certain activities (e.g. “visiting friends”) on a 5-point scale between 0 (“never or seldom did this”) and 4 (“greatly restricted”). All items were summed to create a total score. Cronbach’s alpha for this scale was .86 in the present study.

DATA ANALYSES
First, and following Tabachnick and Fidell (2001) criteria, analyses for sample normality and outliers (univariate and multivariate) were conducted. Then, to control for potential variability in blood pressure derived from the potentially stressful situation of the interview with caregivers, in which discussions of difficult circumstances occurred, we tested whether changes in mean arterial pressure over the interview (at three different time) were significant. With this objective, a mixed-model analysis considering blood pressure as dependent variable and time as predictor was conducted.

Correlation analyses were conducted for analyzing the association between the assessed variables.

For testing the hypothesized model, path analysis was used. As mentioned in the introduction, the path model was developed drawing upon the stress and coping model (Knight and Sayegh, 2010), the pleasant events and activity restriction model (Mausbach et al., 2011), and the path model of chronic stress, the metabolic syndrome, and coronary heart disease (Vitaliano et al., 2002). The path model considered caregivers’ age and gender as context variables, and body mass index and physical exercise as indicators of health habits. These variables were included as key covariates in the model, as they have been established in the literature as important predictors of the main outcome variable of the study (mean arterial pressure). Cognitive function of the relative and frequency of behavioral and psychological symptoms of dementia was included as indicators of caregiving stressors, and reaction to behavioral and psychological symptoms of dementia was included as an appraisal of the stressors. Activity restriction and frequency of pleasant events were entered as resource variables. Finally, mean arterial pressure was included as a health outcome.

The path model was tested using the AMOS software (v.23). First, all the correlations that were shown to be significant in the correlation analyses were established as paths in the model. Then, following the suggestions from Jöreskog and Sörbom (1993), only those associations that remained significant after the first path analysis were included in the final model (this is a common procedure used in previous papers, Fernández-Fernández et al., 2020). For analyzing the fit of the model to the data, and in addition to the χ² statistic, the χ² value divided by the degrees of freedom (χ²/df) was considered, with values under or near 3 indicating a good model fit (Bollen, 1989). The root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker–Lewis index (TLI) were utilized, as additional indicators of model fit, indicating levels close to .06 in the first case and close to .05 in the second and third cases, a good fit to the data (Hu and Bentler, 1999). Direct and indirect associations were analyzed following Preacher and Hayes (2004) recommended bootstrapping approach, using 1000 bootstrap samples, with a bias-corrected confidence interval (CI) of .95. Following the suggestions made by Byrne (2016) and Kim and Millsap (2014), a Bollen–Stine Bootstrap (Bollen and Stine, 1992) was conducted to test the null hypothesis that the specified model was correct.

Results
Characteristics of study participants and measurement of blood pressure
No univariate or multivariate (Mahalanobis’ distance of p < .001) outliers were found. Regarding changes in blood pressure during the assessment process (three measurements of blood pressure were made throughout the interview), the results of the mixed-model analysis showed no significant effects of time from the first to the second blood pressure measure (Intercept = 97.46; Estimate = −.53; standard error [SE] = 50; df = 101; t = −1.06; p = .29; 95% CI, lower bound = −1.52 and upper bound = −.465) nor from the first to the last measure of
blood pressure (Intercept = 95.41; Estimate = .50; SE = .48; df = 101; t = 1.05; p = .30; 95% [CI] lower bound = −.45 and upper bound = 1.44).

Characteristics of the study sample are shown in Table 1.

**Associations between variables of interest**

Correlations between the assessed variables are shown in Table 2. Mean arterial pressure was significantly and positively associated with age and body mass index, and negatively with the frequency of pleasant activities. There was no significant association between activity restriction and mean arterial pressure.

Frequency of behavioral and psychological symptoms of dementia was significantly and positively associated with activity restriction, but not with the frequency of pleasant events. Reaction to behavioral and psychological symptoms of dementia was significantly and positively associated with activity restriction, but showed a negative association with the frequency of pleasant events.

**Path model for mean arterial pressure**

Caregiver gender showed no significant associations in the path model, so it was not included at the final model described below. As shown in Figure 2, higher age (standardized direct effect: 0.289, p < .001, SE = 0.082, CI = 0.130 - 0.465), higher body mass index (standardized direct effect: 0.306, p < .001, SE = 0.079, CI = 0.139 - 0.451), and lower frequency of pleasant events (standardized direct effect: −0.243, p < .01, SE = 0.083, CI = −0.395 - −0.075) were directly associated with higher levels of mean arterial pressure. Also, a significant indirect effect was found between activity restriction and mean arterial pressure (standardized indirect effect: −0.100, p < .01, SE = 0.042, CI = −0.194 - −0.031).

The association between frequency of behavioral and psychological symptoms of dementia and activity restriction was no longer significant when all the variables were considered together, suggesting that the association between these two variables is indirect (standardized indirect effect: 0.228, p < .01, SE = 0.063, CI = 0.114 - 0.355), potentially through their associations with reaction to behavioral and psychological symptoms of dementia. In addition to this, the direct association between reaction to behavioral and psychological symptoms of dementia and frequency of pleasant events found in the correlation analysis was no longer significant when all variables were considered together in the model, suggesting that the relationship between these two variables is indirect, potentially through their associations with activity restriction (standardized indirect effect: −0.151, p < .001, SE = 0.051, CI = −0.262 - −0.061). Also, a significant indirect association was found on path analyses between frequency of behavioral and psychological symptoms of dementia and mean arterial pressure (standardized indirect effect: 0.023, p < .01, SE = 0.013, CI = 0.006 - 0.060) and between reaction to behavioral and psychological symptoms of dementia and mean arterial pressure (standardized indirect effect: 0.037, p < .01, SE = 0.019, CI = 0.009 - 0.088.), potentially through their associations with activity restriction and frequency of pleasant events. Finally, a significant direct association was found between cognitive status of the care recipient and activity restriction (standardized...
The model explained 26% of the variance in activity restriction, 32% of the variance in frequency of pleasant events, and 22% of the variance in mean arterial pressure. The obtained fit indices suggested a good fit of the model to the data ($\chi^2$ (18) = 23.459; $p$ = .174; $\chi^2$/df = 1.303; RMSEA = .055; CFI = .964, and TLI = .944). In addition, the Bollen–Stine Bootstrap showed a good fit of the model, testing the null hypothesis that the model is correct with $p$ = .214.

Using the non-standardized effects from the analyses of mean arterial pressure, for each standard deviation increase in activity restriction, mean arterial pressure increased by 0.961 units.

Discussion

The aim of this study was to analyze the associations between activity restriction, frequency of pleasant events, caregiving stressors, and caregivers’ physical health, specifically blood pressure. We drew upon the stress and coping model adapted to caregiving (Knight and Sayegh, 2010), the pleasant events and activity restriction model (Mausbach et al., 2011), and considered health behaviors variables as suggested in the model proposed by Vitaliano et al. (2002).

The findings suggest that the relationship between caregiving stressors (cognitive status and behavioral and psychological symptoms of dementia) and frequency of pleasant events was indirect, potentially due to the association of these variables with activity restriction. Moreover, the findings suggest that both higher levels of activity restriction and lower frequency of pleasant events are associated with negative caregiving outcomes, in this case with higher blood pressure, after controlling for stressors. Thus, the relationship between activity restriction and blood pressure seems to be indirect, potentially through a negative association with the frequency of pleasant events. Specifically, the results suggest that behavioral and psychological symptoms of dementia impact caregivers’ health by increasing caregivers’ activity restrictions and decreasing their engagement in pleasant activities. The results of our study provide additional support to the findings obtained by Mausbach et al. (2011) and Chattillion et al. (2013), who showed the importance of assessing the joint effects of activity restriction and pleasant events in explaining caregivers’ health. Specifically, the results suggest that greater reaction to behavioral and psychological symptoms of dementia increases caregivers’ stress and reduces their engagement in pleasant activities.
psychological symptoms of dementia may be related to higher perceived activity restriction, which in turn is associated with a lower frequency of pleasant events. In addition, the data suggest a potential indirect association between higher levels of behavioral and psychological symptoms of dementia and a lower frequency of pleasant events, potentially through the association of these two variables with higher levels of activity restriction. In addition, the findings suggest that frequency and reaction to behavioral and psychological symptoms of dementia, along with the cognitive status of the care recipient, may have an indirect association with blood pressure, potentially through associations with the variables activity restriction and frequency of pleasant events. This finding provides support for the previously stated hypothesis that the stress of caregiving may predict a higher perception of activity restriction, which may then lead to a decrease in pursuing leisure activities. Moreover, our findings also lend support to the stress and coping model by showing that, in addition to other resource variables like active coping (Kim et al., 2007), activity restriction and pleasant events are variables that play a significant role in the explanation of caregivers’ physical health.

Finally, although the variance of mean arterial pressure explained by the model was low, and caution is necessary due to the small size of the sample, the obtained effects may contribute significantly to the risk of developing cardiovascular diseases. A one standard deviation decrease in the frequency of pleasant events was associated with an increase of 2.85 units of mean arterial pressure. Similarly, a one standard deviation increase in activity restriction was associated with an increase of 0.987 units of mean arterial pressure. These associations, although small, could have an important clinical impact on caregivers’ cardiovascular risk. As suggested by Lewington and colleagues (Prospective Studies Collaboration, 2002), increase in 10 mmHg of diastolic blood pressure or 20 mmHg of systolic blood pressure over usual blood pressure (115/75 mmHg) are associated with more than a twofold increase in mortality risk from a stroke. Following the calculation formula for mean arterial pressure, this could mean that an increase of 13.33 mmHg over 88.33 mmHg in mean arterial pressure could be associated with a similarly increased risk. Therefore, according to these calculations, a one standard deviation decrease in the frequency of pleasant events could be associated with a 21.38% increased mortality risk from stroke, while a one standard deviation increase in activity restriction would be associated with a 7.40% greater risk. Even though other variables such as body mass index have a more substantial magnitude or effect size on cardiovascular risk, these findings suggest that activity restriction and frequency of pleasant events should be considered among the factors that may act as predictors of cardiovascular morbidity in family caregivers of people with dementia.

Several limitations of our study are noteworthy. First, the cross-sectional nature of the study prevents us from making any causal inferences, and the direction of the associations between variables may be different from those hypothesized in the model. Another potential limitation may relate to the size and convenience nature of our sample, as all participants were volunteers, preventing us from generalizing the results to the whole caregiver population. In addition, as per study exclusion criteria, none of the participants was suffering from severe hypertension, which may limit the generalizability of the results to caregivers with this condition or other relevant cardiovascular problems. An additional limitation of this study is that resting blood pressure was not assessed prior to initiating the caregiver interviews. Instead, the three blood pressure assessments were conducted

Table 3. Unstandardized regression weights

<table>
<thead>
<tr>
<th>Variable</th>
<th>Activity restriction</th>
<th>Mean Arterial Pressure</th>
<th>Reaction to BPSD</th>
<th>Frequency of BPSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive function of the care recipient</td>
<td>2.059**</td>
<td>0.277**</td>
<td>1.123**</td>
<td>0.693**</td>
</tr>
<tr>
<td>Age</td>
<td>0.906**</td>
<td>0.477**</td>
<td>-0.256**</td>
<td>-0.477**</td>
</tr>
<tr>
<td>Physical exercise</td>
<td>0.261</td>
<td>0.175</td>
<td>0.3673</td>
<td>0.261</td>
</tr>
<tr>
<td>Physical exercise</td>
<td>3.475</td>
<td>2.726</td>
<td>4.749**</td>
<td>1.794</td>
</tr>
<tr>
<td>Frequency of pleasant events</td>
<td>4.898**</td>
<td>2.571</td>
<td>-50.670**</td>
<td>17.579</td>
</tr>
<tr>
<td>Activity restriction</td>
<td>1.306</td>
<td>3.644</td>
<td>1.794</td>
<td>2.647</td>
</tr>
<tr>
<td>Frequency of pleasant events</td>
<td>-4.903</td>
<td>-2.726</td>
<td>4.749**</td>
<td>2.647</td>
</tr>
<tr>
<td>Body mass index</td>
<td>3.036</td>
<td>3.475</td>
<td>-50.670**</td>
<td>-2.882</td>
</tr>
<tr>
<td>Age</td>
<td>4.898**</td>
<td>1.794</td>
<td>17.579</td>
<td>2.647</td>
</tr>
<tr>
<td>Frequency of BPSD</td>
<td>0.175</td>
<td>-2.726</td>
<td>4.749**</td>
<td>2.647</td>
</tr>
<tr>
<td>Cognitive function of the care recipient</td>
<td>0.261</td>
<td>0.175</td>
<td>0.3673</td>
<td>0.261</td>
</tr>
</tbody>
</table>

BPSD = Behavioral and psychological symptoms of dementia; SE = Standard error

*p < .05. **p < .01.
prior to, during, and after completing the assessment interviews. For some caregivers, this may have caused variation in blood pressure due to the potentially stressful nature of the questions being asked. Even though we found no significant changes in blood pressure over the interview, we still encourage caution when interpreting the obtained findings, and suggest that future studies assessing blood pressure at rest do so prior to conducting any psychosocial assessments. Finally, although we controlled health characteristics or habits like body mass index or physical exercise, other health behaviors like smoking or alcohol consumption, or use of medication like statins or antihypertensives, suggested to be predictors of cardiovascular risk as well (Harmell et al., 2011; Mausbach et al., 2017; Vara-García et al., 2019; von Känel et al., 2008), were not controlled and could have increased the variance of mean arterial pressure explained by the model. Future studies should try to advance our knowledge in terms of factors contributing to the understanding of caregivers’ activity restriction and engagement in pleasant events, as well as other dimensions that may contribute to their blood pressure and the interplay between these variables and caregivers’ distress or mental health. Longitudinal and experimental studies done with a larger sample size are needed to achieve these aims.

Despite the abovementioned limitations, to our knowledge, this is the first study testing the role of activity restriction and pleasant events as resource variables in the caregiving stress process, as described through the stress and coping model (Knight and Sayegh, 2010). These findings highlight the need to take into consideration the interplay of activity restriction and engagement with pleasant events with other relevant variables highlighted in the stress and coping model, including stressors. If the results of this study were confirmed, targeting sources of activity restriction in highly stressed caregivers could help to raise their engagement in pleasant activities and ultimately decrease cardiovascular risk.

**Description of authors’ roles**

Carlos Vara-García designed the study, collected the data, carried out the statistical analyses, and wrote the paper. Rosa Romero-Moreno supervised the data collection and assisted with writing the article. Brent Mausbach and Roland von Känel assisted with the design and writing the article. Javier Olazarán supervised the design and carried out the recruitment of the participants. María del Sequeros Pedrosor-Chaparro collected the data and assisted with the statistical analysis and writing the article. María Márquez-González assisted with writing the article. Andrés Losada-Baltar assisted with the design, supervised the statistical analyses, and assisted with writing the article.

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