Participation predicts cognitive functioning in older adults using the PART-O transformed scores systems.

Sanchez-Lara, E[1]; Lozano-Ruiz, A[1,2]; Rute-Perez, S[1,3]; Saez-Sanz, N[1]; Bombin, I[4]; Caracuel, A[1,3]

[1]Mind, Brain, and Behavior Research Center (CIMCYC), University of Granada, Granada, Spain

[2]Department of Personality, Evaluation, and Psychological Treatment, University of Granada, Granada, Spain

[3]Department of Developmental and Educational Psychology, University of Granada, Granada, Spain

[4]Reintegra Foundation, Centro de Rehabilitación Neurologica, Oviedo, Spain

Full author names:

- Encarnacion Sanchez-Lara
- Alvaro Lozano-Ruiz
- Sandra Rute-Perez
- Noelia Saez-Sanz
- Igor Bombin
- Alfonso Caracuel

Encarnacion Sanchez-Lara, *MSc. 18071, CIMCYC, Campus de Cartuja, S/N Granada, Spain.*

Email: encarna.msl25@gmail.com

Alvaro Lozano-Ruiz, *MSc. 18071, CIMCYC, Campus de Cartuja, S/N Granada, Spain.*

Email: alvlozanoruiz@gmail.com

Sandra Rute-Perez, *Assistant Professor. 18071, CIMCYC Campus de Cartuja, S/N Granada, Spain. Email: srute@ugr.es*

Noelia Saez-Sanz, *MSc. 1807, CIMCYC Campus de Cartuja, S/N Granada, Spain.*

Email: noesaez@gmail.com

Igor Bombin, *PhD.* Calle de Eduardo de Fraga Torrejón, nº4, bajo, 33011 Oviedo, Asturias. *Email: ibombin@reintegra-dca.es*

Alfonso Caracuel, *PhD*, *Associate Professor. 18071, CIMCYC, Campus de Cartuja, S/N Granada, Spain. Email: acaracuel@ugr.es*

Correspondence concerning this article should be addressed to Encarnación Sánchez-Lara, Mind, Brain, and Behavior Research Center (CIMCYC), University of Granada, Granada, Spain

Email: encarna.msl25@gmail.com

Tlf: +34 958249408

18071 Campus de Cartuja, S/N Granada, Spain.

Conflicts of Interest (COI)

We have no conflict of interest to declare.

IRB protocol/human subjects

University of Granada Research Ethics Committee. Nº. 126/CEIH/2016

Funding Statement

There is no financing for this submission

Participation predicts cognitive functioning in older adults using the PART-O transformed scores systems.

ABSTRACT

Participation has been shown to be a protective factor for cognition in older adults, but instruments to assess it are limited. The main objective was to determine the validity of two scoring systems (direct vs transformed) for the Participation Assessment with Recombined Tools-Objective (PART-O) by applying structural equation modeling to the relationship between the subscales and the cognitive functions, in a sample of 245 people over 60 years of age. The transformed scores model showed stronger relationships and larger explained variance in overall participation (55.4% vs 37.4%), especially in the Social Relations subscale (31.4% vs 14.6%*)*. Participation was a direct predictor of cognitive functions in both models. Age and depression inversely influenced participation in the transformed scores model. The proposed score transformation for the PART-O provides a more appropriate measurement of the older adults´ participation. Participation has a mediating role in the relationship between cognition and both age and depression.

INTRODUCTION

Participation is the combination of various activities that a person carries out with the specific aim of being able to fulfill his or her social roles (Badley, 2008), that is, the performance of the social role as a member of society (Whiteneck & Dijkers, 2009). Nowadays, the construct of participation is so grounded in the exercise of social roles that it is no longer considered necessary to add the qualifier "social" to the concept (Piškur et al., 2014). Therefore, participation could only be evaluated by considering the role played by the person in the subgroups, society in general, and the social environment in which the roles are to be played (performing activities with family, friends, traveling by public transport, receiving academic training...) (Badley, 2008).

There is some evidence to suggest that participation is associated with cognitive status of older adults. Higher participation is related to higher levels of global cognition and lower rates of cognitive decline (Endeshaw & Goldstein, 2021; Kelly et al., 2017; Sun & Lyu, 2020), whereas low participation is a predictor of cognitive decline and dementia (Small et al., 2012). In terms of specific functions, higher engagement has been associated with better performance in visuospatial skills, processing speed, verbal and working memory, and executive functioning (Bourassa et al., 2017; Kelly et al., 2017). Regarding emotional state in older adults, depression seems to be linked to cognitive decline and its progression to dementia (Gallagher et al., 2018; Sachs-Ericsson et al., 2005). Furthermore, longitudinal studies show that depression is an important risk factor for reduced levels of participation (Wang et al., 2020; Wilkie et al., 2016). Therefore, it is possible that high levels of depressive symptomatology lead to lower participation and thus higher risk of cognitive decline. Unfortunately, participation tends to decrease as people age, particularly after the age of 75 years (Pinto et al., 2017). Following the World Health Organization, participation of the older adults should be promoted (Dehi & Mohammadi, 2020).

In terms of measuring facets of participation, the Participation Assessment With Recombined Tools-Objective (PART-O; Whiteneck et al., 2011) has 24 items to assess people as productive members of society (e.g., work, childcare, and household chores), their social integration (interacting with family, friends, and spouses), and community participation (shopping, attending religious services, and going out to eat). Bogner et al. (2011) grouped 17 of the items in three subscales related to the domains of Productivity; Social Relations; and Out and About. They also proposed to replace the original scoring of Whiteneck et al. (2011) with a transformed scores system that allow for obtaining an average score for each subscale. This transformed system modified the original scoring of several items so that all items score homogeneously within a range between 0 and 5. In addition, a balance is achieved between the 3 facets to produce an overall average score of the scale.

PART-O has frequently been used in people with Traumatic Brain Injury (TBI) (Rabinowitz et al., 2020) and Spinal Cord Injury and it has shown to be an instrument with good psychometric properties (Whiteneck et al., 2019). However, despite its long history, the PART-O has not been used to study participation in the older adults. In this population, the most frequent way of recording participation in older adults has consisted of asking them questions designed by the authors to assess the form, degree, or frequency of participation (Bourassa et al., 2017; Mendes de Leon et al., 2003; Santini et al., 2020). There are only two instruments that represent an alternative, but have hardly been used. The first one is the Assessment of Life Habits (Noreau et al., 2004), that measures difficulties in maintaining life habits and the type of assistance needed. This does not provide a measure of the frequency or amount of participation, but of the help needed to perform activities. The second one is the Keele Assessment of Participation (Wilkie et al., 2005), that assesses 11 facets of life. Again, it is not possible to obtain a frequency of participation, but rather aspects such as the degree of performance, individual judgment, and the nature and timing of participation.

The paucity of participation data for older people from validated and standardized instruments makes it difficult to compare the findings across different samples and with other populations.

PART-O has been used in a large sample of adults with TBI in which more than 60% of the participants were not able to enter paid work after 15 years of injury (Whiteneck et al., 2011). This loss of active worker status is a determinant in a person's participation, and is a characteristic shared with the older adults. Given this precedent and the scarcity of validated instruments for assessing participation in the older adults, PART-O is an instrument that could be useful in this population, although we do not know which of the two scoring systems might be more appropriate. Therefore, the first aim of this study was to provide evidence for the validity of Bogner et al. (2011) transformed scoring system for the Participation Assessment with Recombined Tools-Objective (PART-O) and the direct scoring system by modeling the relationship between the three subscales of the instrument and cognitive functions in people over 60 years of age. The second objective was to analyze the influence of age and mood on participation and cognitive functions. For this purpose, structural equation modelling (SEM) was applied to each of the two scoring systems, considering the following hypotheses: 1) at a general level, both models will present a good fit; 2) in both models, participation, age and depression will predict the cognitive function of the participants, and participation will be negatively influenced by both age and depression; and 3) the influence of the latter two variables on cognitive functioning may vary between the models (Model 1 and Model 2) due to the fundamental and mediating role of participation and the transformation of the scales.

METHOD

Participants

Participants were included if they were 60 years of age or older, scored 21 or higher on the Mini- Mental State Examination (MMSE; Folstein et al., 1975) and could understand the test instructions, so they had to be read and write at least at a basic level verified by the evaluator.

At the beginning of the study, 367 older adults were contacted. A total of 122 people were excluded because they did not meet the inclusion criteria. The sample was recruited between September 2018 and February 2020 and was composed of 245 older people (79.2% women), retired, aged between 60 and 91 years (M = 72.04, SD = 7.11) and residing in the community. They were recruited by advertisements in municipal civic centers and day care centers in the metropolitan area of Granada.

Instruments

Participation

"The Participation Assessment with Recombined Tools-Objective scale (PART-O; Whiteneck et al., 2011) was used to measure participation through the quantity, frequency, and type of activities in which a person engages in their fulfillment of social roles. The PART-O items are grouped into three domains: *Productivity:* which assesses household chores; *Social Relations*, which measures how frequently they socialized with friends or family, gave emotional support, communicated via internet, had a spouse or close friend, and were involved in a romantic relationship; and Out and About, which controls the number of times a person leaves home, goes to the shops, restaurants, movies, or religious events, plays sport or attends sporting events, or spends the day away from home. For Model 1, we used the direct scores of the three domains proposed by Whiteneck et al. (2011). For Model 2, we used the average transformed scores proposed by Bogner et al. (2011).

Cognition

To measure cognitive functions, we used the most frequent measures used in the literature. *Learning,* was measured through the number of words recalled on the third trial of the Hopkins Verbal Learning Test-Revised (HVLT- Revised; Benedict et al., 1998) for *Semantic reasoning*, the total correct answers on the Similarities subtest was obtained (Wechsler III, 1997); for *Working memory,* the total correct answers on the Letter-Number Sequence subtest (Wechsler III, 1997); for *Attention*, the concentration index (hits minus errors) of the d2 Test of Attention (Brickenkamp, 1962); for *Fluency*, the sum of correct words in the letters of the F-A-S test (Spreen, 1977) ; and for *Visuospatial abilities,* the scores on the Visuospatial subscale of Addenbrooke's Cognitive Examination III (ACE-III; Noone, 2015) obtained on figure copying (two intersecting infinite loops and a 3D cube), clock drawing, dot counting, and fragmented letter identification tasks. Finally, to measure *Cognitive flexibility*, we used the contrast score Inhibition/Switching vs Inhibition (time part 4 minus time part 3) of the Color Word Interference test (D-KES; Delis et al., 2001).

Depression

To measure depressive symptomatology, we used the global score of the most applied test in this population, the Geriatric Depression Scale (GDS; Yesavage et al., 1982).

Statistical Analysis

Before carrying out structural equation modeling (SEM), the data were subjected to a series of basic assumptions to avoid future problems, errors, and distribution biases. To this end, the variables were analyzed for outliers, as well as their normality through kurtosis and skewness, eliminating those participants with outliers and improving and confirming a normal distribution of all variables. Next, all the variables included in the z-scores model were converted and the zero-correlation matrix was calculated for all of them, both for the raw scores model and the

transformed scores model, ensuring that no correlation showed signs of multicollinearity (>.85).

Once the database met all the requirements to be submitted to SEM, the analyses were carried out for both models, using the Maximum Likelihood (ML) method. All goodness-of-fit values were checked for appropriateness using the following criteria: a Comparative Fit Index (CFI) equal to or greater than >.90, a Root Mean Square Error of Approximation (RMSEA) less than .08 with a non-significant p-value, and a Standardized Root Mean Square Residual (SRMR) less than .08 (Hu & Bentler, 1999). Next, the analysis checked for the presence of high *modification indices* (MI) and Standardized Expected Parameter Change (SEPC) values equal to or greater than .20 (Whittaker, 2012) that would indicate the possibility of improving the models by including a new parameter (e.g., correlation between the covariance of two observable variables). At the level of specific parameters within SEM, the effects of participation, age and depression on cognition, as well as the inverse influence of age and depression on participation, were studied to test hypothesis 2. The mediating effect of participation on the influence of both depression and age on cognition was explored to test hypothesis 3.

All statistical analyses were conducted using R programming language (R Core Team, 2020), Version 4.0.1, with the *lavaan* package (Rosseel, 2012).

RESULT

Descriptive Statistics

The participants obtained on MMSE a mean of 27.84 (SD = 1.69). The sample had a low educational level (M =7.3, SD = 4.86). More than half of the participant were married (53.1%), 33.9% were widowed, 8.2% were divorced and 4.9% were single. Table 1

shows the characteristics of the sample and the descriptive statistics of the variables included in the models.

Table 1

Figure 1 and Figure 2 show the zero-correlation matrix for the variables that were studied in each model, differing only in terms of the three participation variables (Productivity; Social Relations; and Out and About): direct scores (Model 1) and transformed scores (Model 2).

Figure 1

Figure 2

Structural Equation Modeling

The first model analyzed using SEM was with the direct scores of the three PART-O subscales (Figure 3). The fit indices of this model were appropriate, thus confirming hypothesis 1: $\chi 2(50) = 96.078$ ($p < .001$), CFI = .94, RMSEA = .06 (90% CI: .04, .08), p =. 15, and SRMR = .056. No MI or SEPC values were detected that would further improve the model.

Regarding the individual parameters, the latent variable of *participation* presented a sufficient and significant factor loading for the three variables included (Productivity; Social Relations; and Out and About). This *participation* variable was negatively and significantly influenced by both age ($\beta = -.26$, SE = .05, $p < .001$) and depressive symptomatology ($\beta = -.14$, SE = .04, $p = .003$), confirming hypothesis 2.

In turn, *participation* significantly predicted *cognitive functions* (β = .47, SE = .22, p = .036), thereby supporting hypothesis 2. This latent variable of *cognitive functions* also presented significant factor loadings for all the tasks included.

Finally, the *depression* variable failed to directly predict *cognitive functions* (β = -.08, SE = .05, p = .115), and presented no indirect and inverse influence on these through *participation (depression → participation → cognitive functions): β* = -.06, SE = .03, p = .07. Although *age* also did not directly influence *cognitive functions* (β = -.08, SE = .07, p = .267), an effect of this variable was revealed when studying the mediation effect of *participation* on this relationship (*age → participation → cognitive functions):* β = -.12, SE = .06, p = .039).

Figure 3

Moreover, Model 2, in which the transformed scores were used (Figure 4), also presented a good fit, similar to that of Model 1 with the direct scores: $\chi 2(50) = 97.708$ ($p < .001$), CFI .94, RMSEA = .06 (90% CI: .04, .08), p = .128, and SRMR = .057. These goodness-of-fit values confirmed hypothesis 1. There was no indication that the model could be improved by including new parameters, suggesting that the model was already suitable for representing the implicit theory.

Again, all observable variables were significantly saturated within their respective latent variables (i.e., *participation and cognitive functions).*

Individual parameters indicated that *age* (β = -.25, SE = .05, p < .001) and *depression* (β = -.16, SE = .04, p < .001) significantly influenced the *participation* variable*,* these relationships being negative (hypothesis 2).

Cognitive functions were directly predicted by *participation* (β = .82, SE = .40, p = .04), but not by *depression* (β = -.01, SE = .07, p = .862) or *age* (β = .004, SE = .10, p = .862), thus partially confirming hypothesis 1. However, with both variables we found an indirect influence with the presence of *participation* as a mediating variable: *depression* → *participation* → *cognitive functions* (β = -.13, SE = .07, p = .048) and *age* → *participation* → *cognitive functions* (β = -.20, SE = .10, p = .038), thus demonstrating the mediating importance of the *participation* variable in SEM. These mediation analyses, together with those previously reported in Model 1, support hypothesis 3, as the impact of age and depression on cognition varies between Models 1 and 2 when participation mediates this effect.

Figure 4

Although both models presented appropriate overall fits and the hypothesized individual parameters were met, all relationships were stronger in the second Model (see Figure 4), and certain differences were found between the two models in terms of explained variance (i.e., R^2) in *participation.* Thus, while in the model with direct scores, 37.4% of the variance in *participation* was explained by its predictor variables (i.e., age and depression), in the model with transformed scores this variance increased to 55.4%. This discrepancy is also present in the three scores loading on *participation:* in the direct scores model, 23.1% of the variance was explained by *Productivity,* 14.6% by *Social Relations,* and 24% by *Out and About.* In the transformed scores model, 15.5%, 31.4% and 19% of the variance was explained, respectively.

On the other hand, the explained variance in *cognitive functions* did not appreciably change between one model and the other (23.1% for direct scores, and 26.9% for transformed scores). In both models, the three functions the greatest explained variance were *phonological fluency* (36% and 62.8%), *attention* (57.3% and

57.3%), and *working memory* (55.6% and 55.8%). However, *cognitive flexibility* was the variable with the lowest percentage of explained variance (5.4% and 5.5%).

DISCUSSION

The aims of this study were to determine the validity of two scoring system for the PART-O subscales by modeling the relationship between the cognitive functioning of older adults and both types of scores (direct vs transformed), and to analyze the influence of age and mood on participation and cognitive functions. The SEM results revealed that both Model 1 (direct scores) and Model 2 (transformed scores) presented a good fit, and in both, participation directly and positively influenced cognitive functioning, while age and depressive symptomatology inversely predicted the participation score in both models. However, the results were different in terms of the mediating role of participation on the influence of age and depression on cognition. While age maintained a significant and inverse influence in both models, depression only indirectly predicted cognitive functioning in Model 2. This discrepancy is also reflected in terms of the explained variance in participation. In Model 2, this variance increased considerably for the latent variable of participation and increased in the social relations domain to more than double the value in Model 1. Thus, our findings indicate the importance of participation on cognition in older people, as well as the validity of transforming domain scores, since this allows us to determine how the different domains of participation can modulate cognitive functioning in the population of people over 60 years of age.

Regarding direct associations, the positive relationship between participation and cognitive functions in older people is supported by previous findings in which higher participation was associated with better cognitive functioning (Bourassa et al., 2017; Sun & Lyu, 2020), specifically for processing speed, working memory,

visuospatial skills, and executive functioning (Kelly et al., 2017). On the other hand, the negative relationship between age and participation can be explained by the results of previous studies using different paradigms. First, the disengagement theory (Klussman et al., 2020) postulates that as people age they experience limiting physical changes that promote a psychological and social withdrawal from the environment. This withdrawal process, however, does not occur in everyone, and the activity theory (Knapp, 1977) posits that there are some older people who maintain higher levels of participation because they take on new productive roles in society to replace those lost due to age. Complementarily, the accumulation theory (Bukov et al., 2002) adds that, in this process of restricted participation, older people carry out activities selectively, giving priority to less demanding tasks and abandoning those that carry a greater burden. However, people who, in this selection process, maintain their participation in highly-demanding activities show a higher overall level of participation because they also continue with less demanding activities. The authors of a review study on participation trajectories in old age concluded that the most frequent trajectory among older people was the one leading to social disengagement resulting from a reduction in social networks, accompanied by a decrease in participation (Pinto et al., 2017). Furthermore, they found that, along with the aforementioned activity theory, the most frequent explanatory theory is that of socioemotional selectivity. This argues older people choose to maintain activities according to whether they are meaningful and provide sources of support, and thus pleasure and satisfaction. In contrast, they gradually leave aside those that are costly, complex, stressful, or a source of negative affect. The theory of socioemotional selection is broader and encompasses the accumulation theory proposed by Bukov et al. (2002). Thus, it is possible to explain the indirect association between age and cognition in which participation acts as a mediating variable in both models.

Moreover, both models show a direct and negative relationship between depressive symptomatology and participation. This finding has previously been reported by Wilkie et al. (2016) in a large sample of older people. However, only the transformed scores from Model 2 show that there is an indirect relationship between depression and cognition which is mediated by participation. The literature is conclusive about the fact that there is a strong relationship between depressive symptoms and cognitive performance in older people (Braund et al., 2020). However, as far as we know, the present study is the first to demonstrate that participation plays a role in explaining the known association between depression and cognition in older people.

Finally, we found a large difference in the explained variance in social relationships in Model 1 with respect to Model 2 (with a difference of more than double). This suggests that social relations are highly influenced by the exogenous variables of Model 2 (i.e., age and depression). In any case, this participation component stands out above the other two variables (Productivity and Out and About) in the second model, with participation being a strong predictor of cognitive functioning. This leading role of social relationships in our model is consistent with previous findings that older people with higher levels of social relationships maintain good cognitive functioning into their 80s, compared with those with fewer social relationships (Béland et al., 2005). Low levels of social relationships due to the loss of a spouse, loss of contact with family or others constitute a risk factor for cognitive decline (Bassuk et al., 1999) in which the perception of loneliness plays a mediating role (Yang et al., 2020). In contrast, the existence of a social network with which to maintain relationships has an enhancing effect on cognitive functioning in older people (Seeman et al., 2011).

Many factors have been discovered to be related to cognition, including age, education level, stroke, cardiovascular disease (Mohd Zulkifly et al., 2016; Tsang et al.,

2019), body mass index (Buie et al., 2019) and physical exercise (Endeshaw & Goldstein, 2021). In addition, the low economic status of older adults can prevent them from participating in health promotion programs (Lorthios-Guilledroit et al., 2020). In this study, we have not studied the relationship of participation with the aforementioned risk factors associated with cognition. However, we have found a relationship between participation and depression, a factor previously evidenced as a risk for cognition in the older adults (Gallagher et al., 2018). Therefore, future research should include participation as one more of these factors and deepen these relationships. This will allow for more targeted interventions when older people have more than one of these risks.

This is the first study to examine the relationship between participation measured with the PART-O instrument and cognitive functioning in people over 60 years of age. However, only by using the transformed scores, as proposed Bogner et al. (2011) has it been possible to identify the mediating role of participation in the relationship between cognitive state and variables relevant to older people such as age and depressive symptomatology. Taking participation into account as an important factor in the association between mood and cognition has theoretical and practical implications when designing interventions aimed at older people. From a theoretical standpoint, we have shown the need to adapt the scoring systems of the instruments to adequately capture the peculiarities of participation in the older population, as well as to demonstrate their validity. The use of SEM has made it possible to compare models and to validate a scoring system applicable to the older population, with the advantage of revealing indirect relationships that are difficult to observe with other methods. These findings open avenues for future studies aimed at demonstrating causal relationships between these variables. Finally, this study has socio-health implications. For instance, our findings suggest the need to include an evaluation of participation (and its dimensions) in the cognitive and emotional assessment of older people to obtain more

effective diagnoses and intervention proposals that consider the relationship between depressive symptoms, participation, and cognition. Our results indicate that the associations between participation and the components of cognitive function have been greater for phonological fluency, attention and working memory, and so these components could benefit most when participation levels are higher. Moreover, given that the items of the scale do not reflect aspects linked to a specific culture, the PART-O instrument could readily be applied at an international level. Finally, the effects of autonomous participation and participation supported by others should be investigated.

This study has several limitations. First, this is the first time that PART-O has been used in older persons, and therefore, there are no equivalent findings for comparison. Second, PART-O is an objective measure of participation, so future studies could include the subjective component, referring to satisfaction with the activities carried out and subjective impressions of the importance of participation. Third, we have not considered other emotional variables such as stress or anxiety, which could play a role in the associations between participation and the variables studied in the present research.

CONCLUSION

The adapted PART-O system using transformed scores in the three domains of participation proposed by Bogner et al. (2011) is more appropriate than direct scores and allows for the scale to be applied as a valid instrument for measuring participation in people over 60 years of age. A direct association has been found between participation and the cognitive functioning of older people, as well as a mediating role of participation in the relationship between cognition and both age and depressive symptomatology.

REFERENCES

Badley, E. M. (2008). Enhancing the conceptual clarity of the activity and participation components of the International Classification of Functioning, Disability, and Health. *Social Science & Medicine*, *66*(11), 2335–2345. https://doi.org/10.1016/j.socscimed.2008.01.026

Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social Disengagement and Incident Cognitive Decline in Community-Dwelling Elderly Persons. *Annals of Internal Medicine*, *131*(3), 165–173. https://doi.org/10.7326/0003-4819-131-3-199908030-00002

Béland, F., Zunzunegui, M.-V., Alvarado, B., Otero, A., & del Ser, T. (2005). Trajectories of Cognitive Decline and Social Relations. *The Journals of Gerontology: Series B*, *60*(6), P320–P330. https://doi.org/10.1093/geronb/60.6.P320

Benedict, R. H. B., Schretlen, D., Groninger, L., & Brandt, J. (1998). Hopkins Verbal Learning Test – Revised: Normative Data and Analysis of Inter-Form and Test-Retest Reliability. *The Clinical Neuropsychologist*, *12*(1), 43–55. https://doi.org/10.1076/clin.12.1.43.1726

Bogner, J. A., Whiteneck, G. G., Corrigan, J. D., Lai, J.-S., Dijkers, M. P., & Heinemann, A. W. (2011). Comparison of Scoring Methods for the Participation Assessment With Recombined Tools–Objective. *Archives of Physical Medicine and Rehabilitation*, *92*(4), 552–563. https://doi.org/10.1016/j.apmr.2010.11.014

Bourassa, K. J., Memel, M., Woolverton, C., & Sbarra, D. A. (2017). Social participation predicts cognitive functioning in aging adults over time: Comparisons with physical health, depression, and physical activity. *Aging & Mental Health*, *21*(2), 133–146. https://doi.org/10.1080/13607863.2015.1081152

Braund, T. A., Tillman, G., Palmer, D. M., & Harris, A. W. F. (2020). Verbal memory predicts treatment outcome in syndromal anxious depression: An iSPOT-D report. *Journal of Affective Disorders*, *260*, 245–253. https://doi.org/10.1016/j.jad.2019.09.028

Brickenkamp, R. (1962). *Test d2: Aufmerksamkeits-Belastungs-Test*.

Buie, J. J., Watson, L. S., Smith, C. J., & Sims-Robinson, C. (2019). Obesity-related cognitive impairment: The role of endothelial dysfunction. *Neurobiology of Disease*, *132*, 104580. https://doi.org/10.1016/j.nbd.2019.104580

Bukov, A., Maas, I., & Lampert, T. (2002). Social Participation in Very Old Age: Cross-Sectional and Longitudinal Findings From BASE. *The Journals of Gerontology: Series B*, *57*(6), P510–P517. https://doi.org/10.1093/geronb/57.6.P510

Dehi, M., & Mohammadi, F. (2020). Social Participation of Older Adults: A Concept Analysis. *International Journal of Community Based Nursing & Midwifery*, *8*(1), 55–72. https://doi.org/10.30476/ijcbnm.2019.82222.1055

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System*.

Endeshaw, Y., & Goldstein, F. (2021). Asociación entre el ejercicio físico y la función cognitiva entre los adultos mayores que viven en la comunidad. *Journal of Applied Gerontology*, *40*(3), 300–309. https://doi.org/10.1177/0733464820952242

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-mental state”: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*(3), 189–198.

Gallagher, D., Kiss, A., Lanctot, K., & Herrmann, N. (2018). Depression and Risk of Alzheimer Dementia: A Longitudinal Analysis to Determine Predictors of Increased Risk among Older Adults with Depression. *The American Journal of Geriatric Psychiatry*, *26*(8), 819–827. https://doi.org/10.1016/j.jagp.2018.05.002

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Kelly, M. E., Duff, H., Kelly, S., McHugh Power, J. E., Brennan, S., Lawlor, B. A., & Loughrey, D. G. (2017). The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: A systematic review. *Systematic Reviews*, *6*(1), 259. https://doi.org/10.1186/s13643-017-0632-2

Klussman, K., Nichols, A. L., Langer, J., & Curtin, N. (2020). Connection and disconnection as predictors of mental health and wellbeing. *International Journal of Wellbeing*, *10*(2), Article 2. https://doi.org/10.5502/ijw.v10i2.855

Knapp, M. R. (1977). The activity theory of aging an examination in the English context. *The Gerontologist*, *17*(6), 553–559.

Lorthios-Guilledroit, A., Parisien, M., Nour, K., Fournier, B., Guay, D., & Bier, N. (2020). Programa de promoción de la salud cognitiva para personas mayores que viven en la comunidad: ¿A quién estamos llegando? *Journal of Applied Gerontology*, *39*(6), 588–600. https://doi.org/10.1177/0733464818790190

Mendes de Leon, C. F., Glass, T. A., & Berkman, L. F. (2003). Social Engagement and Disability in a Community Population of Older Adults: The New Haven EPESE. *American Journal of Epidemiology*, *157*(7), 633–642. https://doi.org/10.1093/aje/kwg028

Mohd Zulkifly, M. F., Ghazali, S. E., Che Din, N., Singh, D. K. A., & Subramaniam, P. (2016). A Review of Risk Factors for Cognitive Impairment in Stroke Survivors. *The Scientific World Journal*, *2016*, e3456943. https://doi.org/10.1155/2016/3456943

Noone, P. (2015). Addenbrooke's cognitive examination-III. *Occupational Medicine*, *65*(5), 418–420.

Noreau, L., Desrosiers, J., Robichaud, L., Fougeyrollas, P., Rochette, A., & Viscogliosi, C. (2004). Measuring social participation: Reliability of the LIFE-H in older

adults with disabilities. *Disability and Rehabilitation*, *26*(6), 346–352. https://doi.org/10.1080/09638280410001658649

Pinto, J. M., Neri, A. L., Pinto, J. M., & Neri, A. L. (2017). Trajetórias da participação social na velhice: Uma revisão sistemática da literatura. *Revista Brasileira de Geriatria e Gerontologia*, *20*(2), 259–272. https://doi.org/10.1590/1981-22562017020.160077

Piškur, B., Daniëls, R., Jongmans, M. J., Ketelaar, M., Smeets, R. J., Norton, M., & Beurskens, A. J. (2014). Participation and social participation: Are they distinct concepts? *Clinical Rehabilitation*, *28*(3), 211–220.

R Core Team. (2020). *R: A language and environment for statistical computing*. https://www.r-project.org/

Rabinowitz, A. R., Chervoneva, I., Hart, T., O'Neil-Pirozzi, T. M., Juengst, S. B., & Hoffman, J. M. (2020). Heterogeneity in Temporal Ordering of Depression and Participation After Traumatic Brain Injury. *Archives of Physical Medicine and Rehabilitation*, *101*(11), 1973–1979. https://doi.org/10.1016/j.apmr.2020.05.026

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling and more. Version 0.5–12 (BETA). *Journal of Statistical Software*, *48*(2), 1–36.

Sachs-Ericsson, N., Joiner, T., Plant, E. A., & Blazer, D. G. (2005). The Influence of Depression on Cognitive Decline in Community-Dwelling Elderly Persons. *The American Journal of Geriatric Psychiatry*, *13*(5), 402–408. https://doi.org/10.1097/00019442-200505000-00009

Santini, Z. I., Jose, P. E., Koyanagi, A., Meilstrup, C., Nielsen, L., Madsen, K. R., & Koushede, V. (2020). Formal social participation protects physical health through enhanced mental health: A longitudinal mediation analysis using three consecutive waves of the Survey of Health, Ageing and Retirement in Europe (SHARE). *Social Science & Medicine*, *251*, 112906. https://doi.org/10.1016/j.socscimed.2020.112906

Seeman, T. E., Miller-Martinez, D. M., Stein Merkin, S., Lachman, M. E., Tun, P. A., & Karlamangla, A. S. (2011). Histories of Social Engagement and Adult Cognition: Midlife in the U.S. Study. *The Journals of Gerontology: Series B*, *66B*(suppl_1), i141–i152. https://doi.org/10.1093/geronb/gbq091

Small, B. J., Dixon, R. A., McArdle, J. J., & Grimm, K. J. (2012). Do changes in lifestyle engagement moderate cognitive decline in normal aging? Evidence from the Victoria Longitudinal Study. *Neuropsychology*, *26*(2), 144.

Spreen, O. (1977). Neurosensory center comprehensive examination for aphasia. *Neuropsychological Laboratory*.

Sun, J., & Lyu, S. (2020). Social participation and urban-rural disparity in mental health among older adults in China. *Journal of Affective Disorders*, *274*, 399–404. https://doi.org/10.1016/j.jad.2020.05.091

Tsang, S., Sperling, S. A., Park, M.-H., Helenius, I. M., Williams, I. C., & Manning, C. (2019). Las variables de salud son informativas en la detección de deterioro cognitivo leve entre afroamericanos ancianos. *Journal of Applied Gerontology*, *38*(10), 1421–1444. https://doi.org/10.1177/0733464817711961

Wang, R., Feng, Z., Liu, Y., & Lu, Y. (2020). Relationship between neighbourhood social participation and depression among older adults: A longitudinal study in China. *Health & Social Care in the Community*, *28*(1), 247–259. https://doi.org/10.1111/hsc.12859

Wechsler III, D. (1997). *WMS-III Administration and Scoring Manual. San Antonio, TX: The Psychological Corporation*.

Whiteneck, G., & Dijkers, M. P. (2009). Difficult to Measure Constructs: Conceptual and Methodological Issues Concerning Participation and Environmental Factors. *Archives of Physical Medicine and Rehabilitation*, *90*(11, Supplement), S22–S35. https://doi.org/10.1016/j.apmr.2009.06.009

Whiteneck, G. G., Dijkers, M. P., Heinemann, A. W., Bogner, J. A., Bushnik, T., Cicerone, K. D., Corrigan, J. D., Hart, T., Malec, J. F., & Millis, S. R. (2011). Development of the Participation Assessment With Recombined Tools–Objective for Use After Traumatic Brain Injury. *Archives of Physical Medicine and Rehabilitation*, *92*(4), 542–551. https://doi.org/10.1016/j.apmr.2010.08.002

Whiteneck, G. G., Gassaway, J., & Ketchum, J. M. (2019). Transforming a Traumatic Brain Injury Measure of Participation Into a Psychometrically Sound Spinal Cord Injury Participation Measure. *Archives of Physical Medicine and Rehabilitation*, *100*(12), 2293–2300. https://doi.org/10.1016/j.apmr.2019.06.020

Whittaker, T. A. (2012). Using the modification index and standardized expected parameter change for model modification. *The Journal of Experimental Education*, *80*(1), 26–44.

Wilkie, R., Blagojevic-Bucknall, M., Belcher, J., Chew-Graham, C., Lacey, R. J., & McBeth, J. (2016). Widespread pain and depression are key modifiable risk factors associated with reduced social participation in older adults. *Medicine*, *95*(31), e4111. https://doi.org/10.1097/MD.0000000000004111

Wilkie, R., Peat, G., Thomas, E., Hooper, H., & Croft, P. R. (2005). The Keele Assessment of Participation: A New Instrument to Measure Participation Restriction in Population Studies. Combined Qualitative and Quantitative Examination of its Psychometric Properties. *Quality of Life Research*, *14*(8), 1889–1899. https://doi.org/10.1007/s11136-005-4325-2

Yang, R., Wang, H., Edelman, L. S., Tracy, E. L., Demiris, G., Sward, K. A., & Donaldson, G. W. (2020). Loneliness as a mediator of the impact of social isolation on cognitive functioning of Chinese older adults. *Age and Ageing*, *49*(4), 599–604. https://doi.org/10.1093/ageing/afaa020

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, *17*(1), 37–49.