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Identifying Behavioral Correlates and Pathways for Elderly Wellbeing During the Pandemic



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Agenda

- Introduction and study motivation
- Goals of the study
- Review of literature
- Approach
- Methods
- Results
- Summary

Introduction and Study Motivation

- The COVID-19 pandemic has had far reaching mental health impact: 4 in 10 adults in the US have reported symptoms of anxiety or depression, up from one in ten adults who reported these conditions between January-June 2019.
- Reports of sleep irregularities, alcohol consumption, substance abuse, worry, stress, worsening chronic conditions owing to factors such as growing isolation, widespread job loss, unemployment.
- We focus our research on older adults in this paper because while there has been a markedly lower/unchanged trend in the nature and extent of impact of the pandemic on older adults' mental health, these studies have been done at an earlier time in the pandemic and even then, remain cross sectional.
- Therefore, the full extent of the longitudinal impact of the pandemic on older adults' mental health outcomes is unclear (Vahia et al., 2020).

Goals of the Study

1. Study the interrelationships among the various mental health indicators on outcomes among older adults
2. Examine the pathways by which these factors, which are behavioral, social, physical and environmental impact outcomes for older adults, and
3. Apply emerging data analytic techniques from disciplines such as data science to examine these longitudinal trends in behavioral data.

Literature review

- Wellbeing in general is defined as the quality of life, with a positive perception towards satisfaction in life, health, education, relationships, future, etc. (Diener et al., 1997; Veehoven, 2008).
- Quantifiable measure for public policy and is related to depression, anxiety, stress, cognitive well-being, productivity, social connectedness etc. (Diener and Seligman, 2004; Lyubomirsky et al., 2005).
- Impact of COVID-19 for people with preexisting mental health conditions, vulnerable populations, those with other preexisting comorbidities, etc., has been examined in depth.
- The pandemic also triggered significant adverse impacts in terms of isolation leading to reduced social life, interaction and increased entrapment, suicidal thoughts, loneliness, depression, anxiety, self-harm and relapse of pre-mental health problems (Newman, 2020; O'Connor et al., 2020; Gopal et al., 2020, Jakobsen et al., 2020).

Our Approach

- Correlation and regression analysis widely applied in different areas of behavioral sciences (Cohen et al., 2013).
- Using regression, vulnerability and protective factors that potentially influence the wellbeing and cognitive functioning in the elderly during the pandemic have also been studied (De Pue et al., 2021).
- In contrast, we perform item level analysis for the correlation between different scale items showing intra-scale correlation, inter-scale correlations and change before and during COVID-19 between items based on inter-scale correlation analysis.
- This helps us to pin-point the important factors that affect one another and gives us a validation for the results from the causal analysis.
- Causal theory has been used in multiple research domains such as biology, medicine, epidemiology, psychology, politics etc. (Pearl, 2009; Bunge, 2017; Dessler, 1991; Chiolero, 2014).
- Further, for exploring the factors and the pathways which are important for showing the cause-and-effect relationships (directionality), we employ a causal structure (graph) learning technique over which graph betweenness metrics were used to filter the items (nodes) in the learnt graph.

Dataset

- Survey done in Belgium on 640 older adults age 65 and above.
- Age, gender, nationality, living situation, number of cohabitants, number of contacts during the past week (excluding cohabitants), the highest level of education, work situation, monthly individual net income (in Euros), medical history, COVID-19 contagion of the participant, COVID-19 contagion of at least one close relative or friend, the week when the survey was completed.
- Along with **scales** to measure
  - Positive wellbeing using Positive Wellbeing Index (PWI),
  - Depression using The Geriatric Depression Scale (GDS),
  - Social network contacts using Lubben Social Network Scale (LSNS),
  - Resilience using Brief Resilience Scale (BRS) and
  - Cognitive functioning using Cognitive Failures Questionnaire (CFQ) scale.

De Pue, S., Gillebert, C., Dierckx, E., Vanderhasselt, M.A., De Raedt, R. and Van den Bussche, E., 2021. The impact of the COVID-19 pandemic on wellbeing and cognitive functioning of older adults. Scientific reports, 11(1), pp.1-11.

Table 1: The Lubben Social Network Scale (LSNS-6) items[2].

LSNS Item no.	Item
1	How many relatives do you see or hear from at least once a month?
2	How many relatives do you feel at ease with that you can talk about private matters?
3	How many relatives do you feel close to such that you could call on them for help?
4	How many of your friends do you see or hear from at least once a month?
5	How many friends do you feel at ease with that you can talk about private matters?
6	How many friends do you feel close to such that you could call on them for help?

Table 2: The Geriatric Depression Scale (GDS) items[3].

GDS Item no.	Items
1	Are you basically satisfied with your life?
2	Have you dropped many of your activities and interests?
3	Do you feel that your life is empty?
4	Do you often get bored?
5	Are you in good spirits most of the time?
6	Are you afraid that something bad is going to happen to you?
7	Do you feel happy most of the time?
8	Do you often feel helpless?
9	Do you prefer to stay at home, rather than going out and doing new things?
10	Do you feel you have more problems with memory than most?
11	Do you think it is wonderful to be alive now?
12	Do you feel pretty worthless the way you are now?
13	Do you feel full of energy?
14	Do you feel that your situation is hopeless?
15	Do you think that most people are better off than you are?

Table 3: Positive Well-being Index (PWI) items[4].

PWI Item no.	Item meaning
1	How satisfied are you with your standard of living?
2	How satisfied are you with your health?
3	How satisfied are you with what you are achieving in life?
4	How satisfied are you with your personal relationships?
5	How satisfied are you with how safe you feel?
6	How satisfied are you with feeling part of your community?
7	How satisfied are you with your future security?
8	How satisfied are you with your spirituality or religion?

Methods Overview

- Bi-directional relationship between variables.
- Types of analysis done:
  - Intra-scale.
  - Inter-scale.
  - Change in inter-scale.
- The correlated items based on the Cohen, 1988 categorization of
  - Low (< 0.3),
  - Medium (0.3 - 0.5) and
  - High (>0.5) correlations are further analyzed at the qualitative level.
- Viz: Heatmaps with dendrograms for clustering similar items.
- Causal and graph analysis:
  - Pipeline discussed in methods applied to arrive at the final subgraph in Figure 9.

Methods: Correlation Analysis

- Correlation:
  - Intra-scale:
    - LSNS, PWI(A), GDS(A), BRS(A), CFQ(A)
  - Inter-scale:
    - Social network and depression
    - Cognition and depression
    - Resilience and Demographics - age, gender, living situation, work situation, monthly income and cohabitants (A)
  - Change in inter-scale:
    - Positive-wellbeing and depression

Results: Correlation Analysis

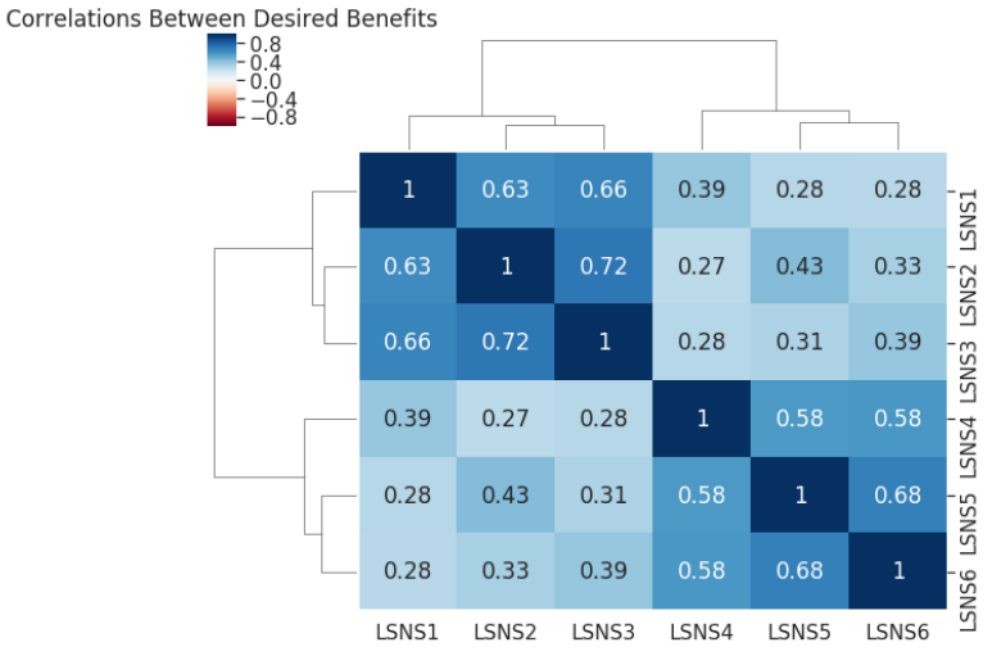


Figure 1: The intra-scale correlation heatmap of LSNS items with hierarchical clustering dendograms.

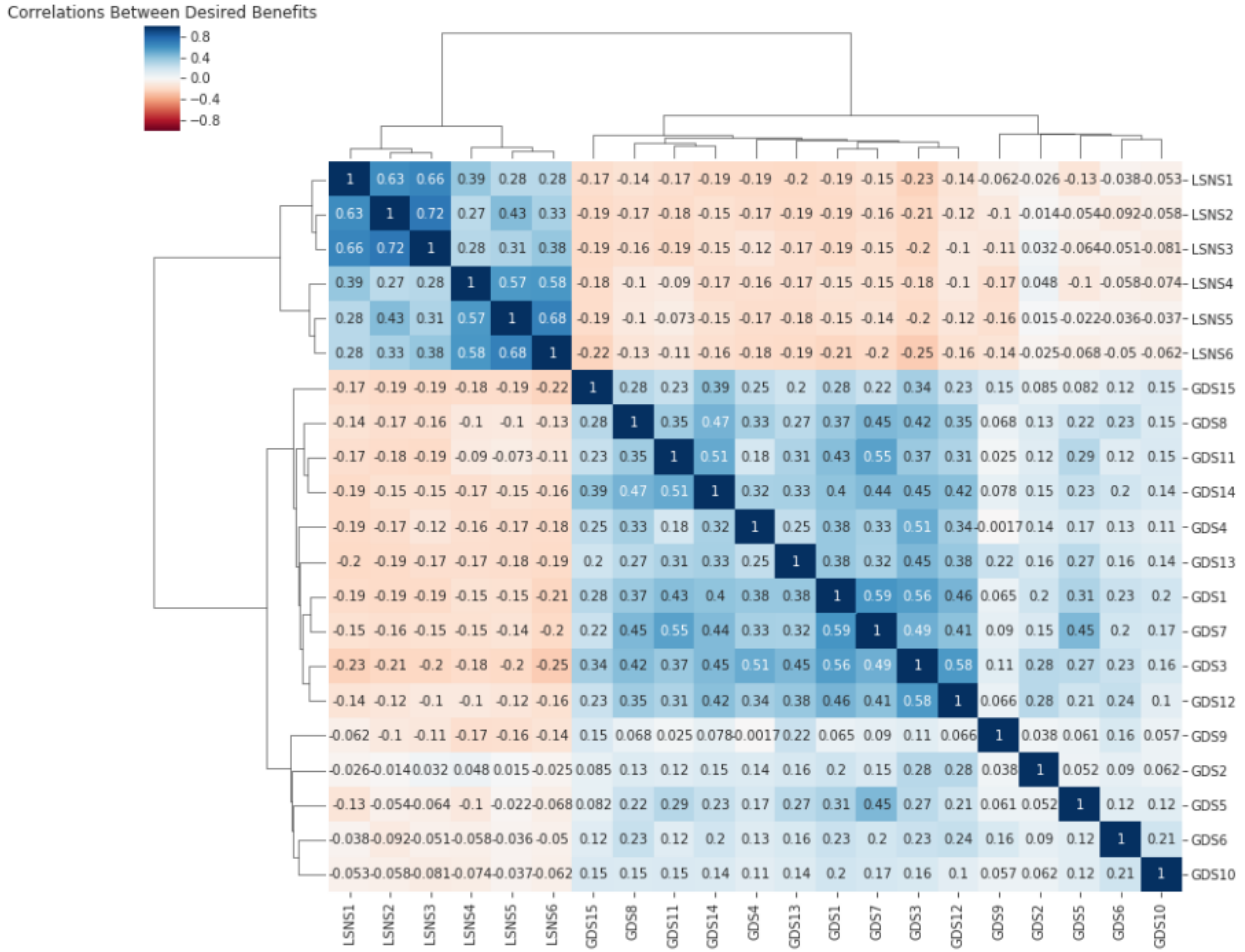


Figure 2: The inter-scale correlation heatmap of LSNS and GDS items with hierarchical clustering dendograms.

Results: Correlation Analysis

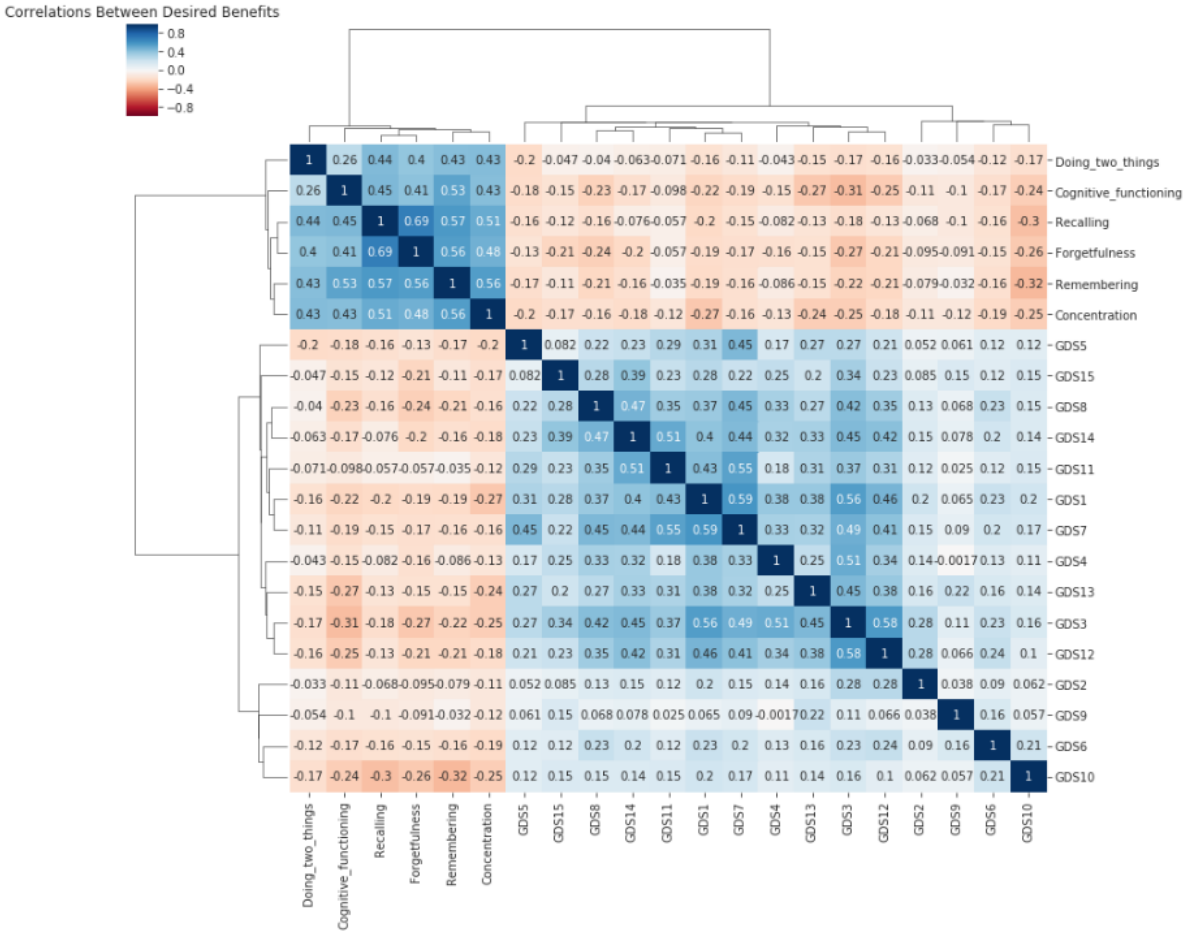


Figure 3: The inter-scale correlation heatmap of Cognitive Subjective Change and GDS items with hierarchical clustering dendograms.

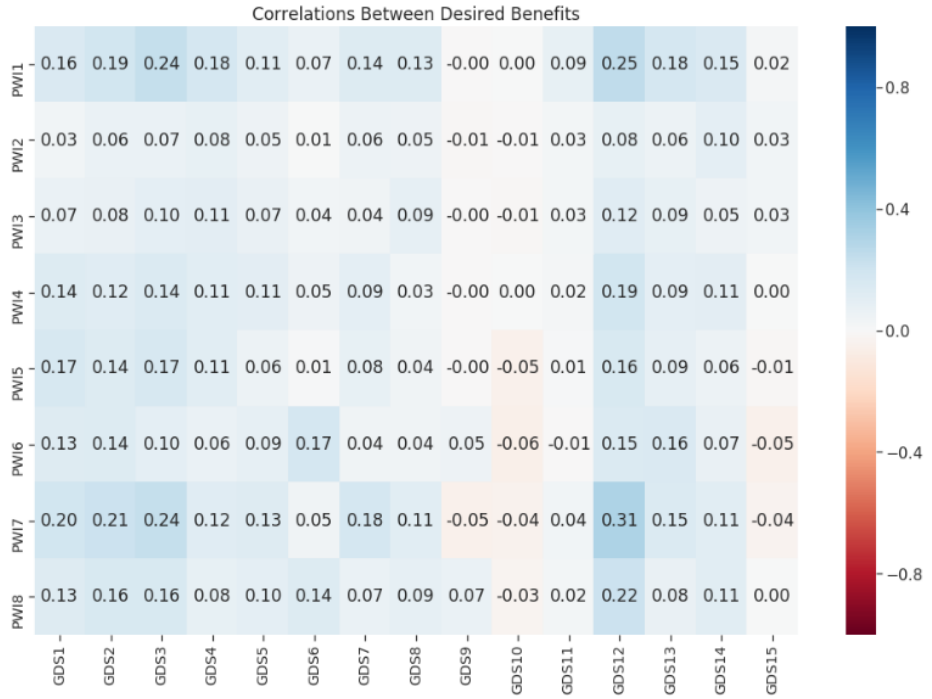


Figure 4: Heatmap of change in correlation of PWI items between pre COVID-19 and during COVID-19 period.

Table 4: Change in correlation between PWI and GDS item from before and during COVID-19.

PWI Item no.	GDS Item (change in correlations) in decreasing order
1	3 (0.24), 2 (0.19), 13 (0.18), 4 (0.18), 1 (0.16)
2	12 (0.08), 4 (0.08), 3 (0.06), 2 (0.06), 7 (0.06)
3	4 (0.11), 3 (0.10), 8 (0.09), 13 (0.09), 2 (0.08)
4	3 (0.14), 1 (0.14), 2 (0.12), 4 (0.11), 14 (0.11)
5	3 (0.17), 12 (0.16), 2 (0.14), 4 (0.11), 13 (0.09)
6	13 (0.16), 12 (0.15), 2 (0.14), 1 (0.13), 3 (0.10)
7	3 (0.24), 2 (0.21), 1 (0.20), 7 (0.18), 13 (0.15)
8	3 (0.16), 2 (0.16), 6 (0.14), 1 (0.13), 14 (0.11)

Methods: Causal Analysis and Graph Analysis

- Unidirectional; cause and effect relationships between variables and pathways.
- Hill-climb algorithm with BIC (Bayesian Information Criterion) scoring for edge weights.
- 108 variables→summed scores of variables & other independent variables→35 variables to be analyzed
- Pipeline:
  i. Coarse-grained view (35 total scale scores only + others)
  ii. Graph betweenness metrics applied (bridging, stress, betweenness, edge betweenness)
  iii. Fine-grained view (filtered nodes from step 2)
  iv. Item level expansion (of scale nodes)
  v. Graph betweenness metrics applied again
  vi. Final item level subgraph (filtered form step 5)
- **Viz**: Cytoscape;
  i. Hierarchical layout (left to right l parent to children arrow)
  ii. Coloring:
    - Nodes based on the domain to which the node belongs:
    - Edges based on edge weights divided into 4 categories using natural breaks.

Results: Causal Analysis

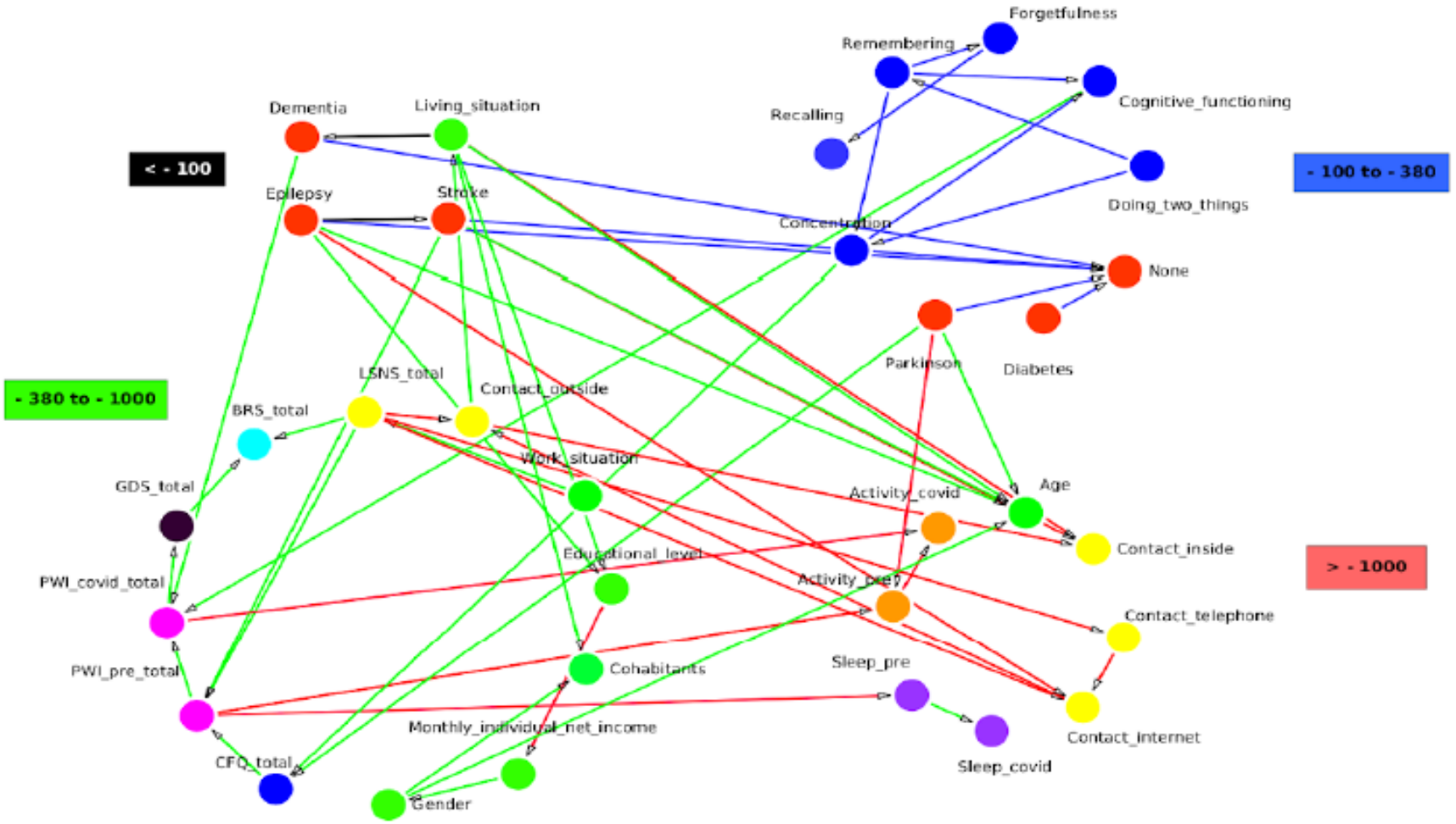


Figure Appendix 1: The categorical layout of the causal relationships at coarse-grained level.

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Results: Causal Analysis

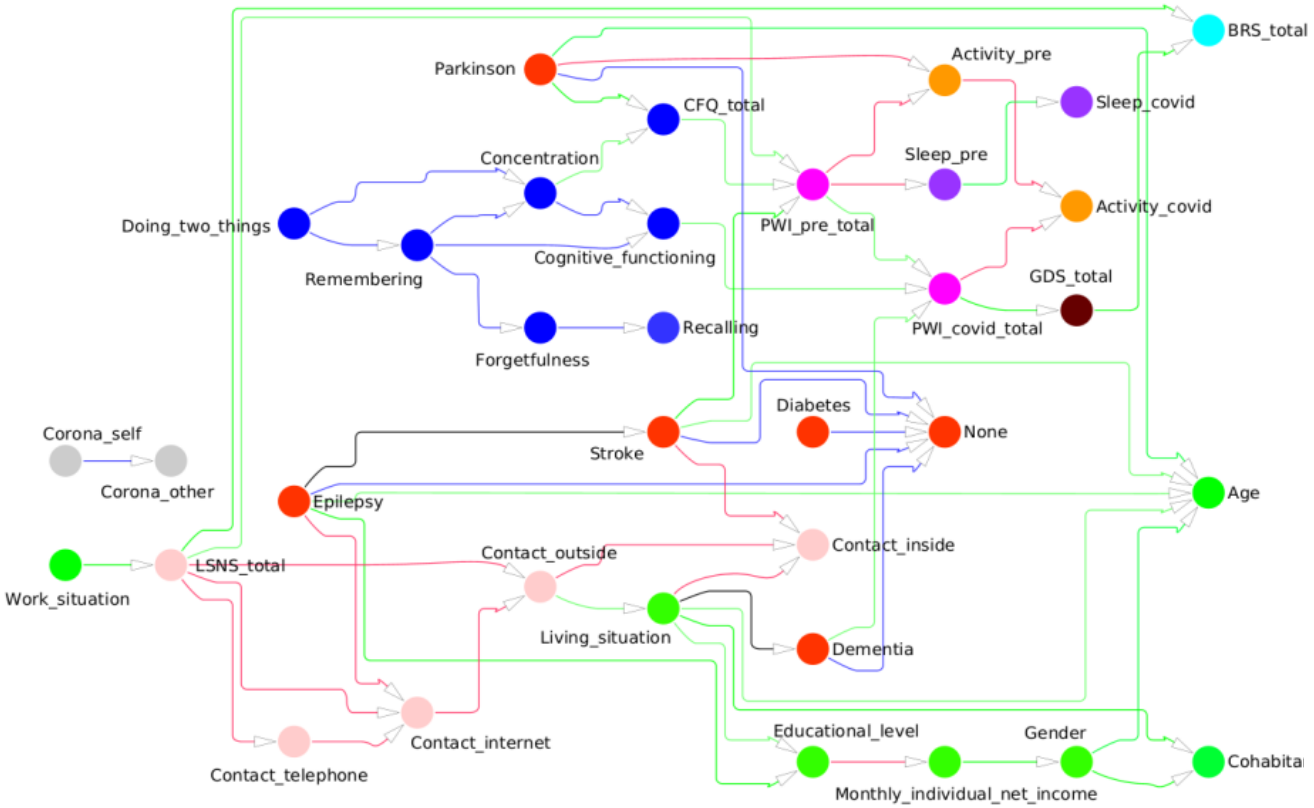


Figure 5: The hierarchical coarse-grained the causal relations. The nodes are colored based on the domains. The edges have direction from parent to child with coloring based on the causal score (BIC) categorized into 4 categories (Black>Blue>Green>Red).

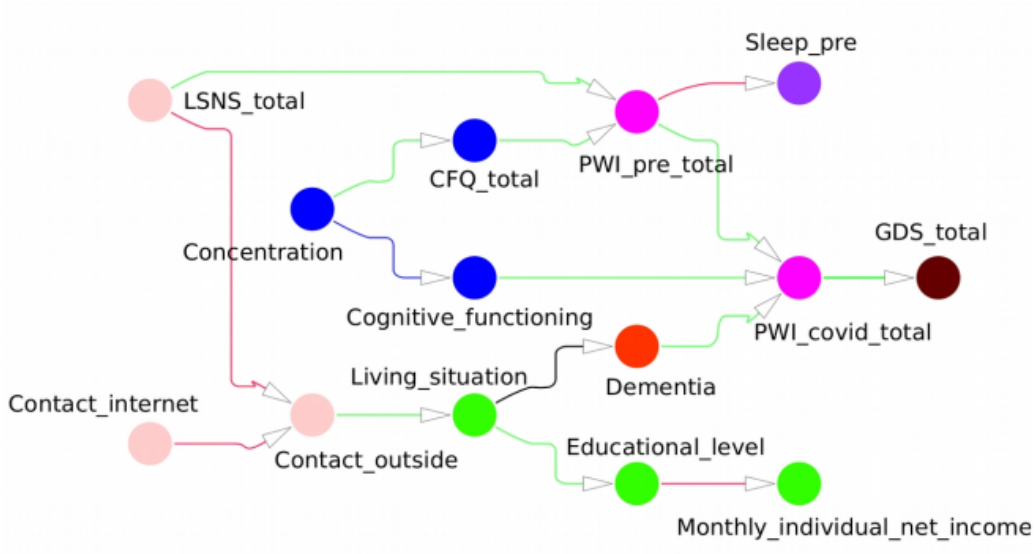


Figure 6: Hierarchical causal subgraph obtained through graph filtering.

Results: Causal Analysis

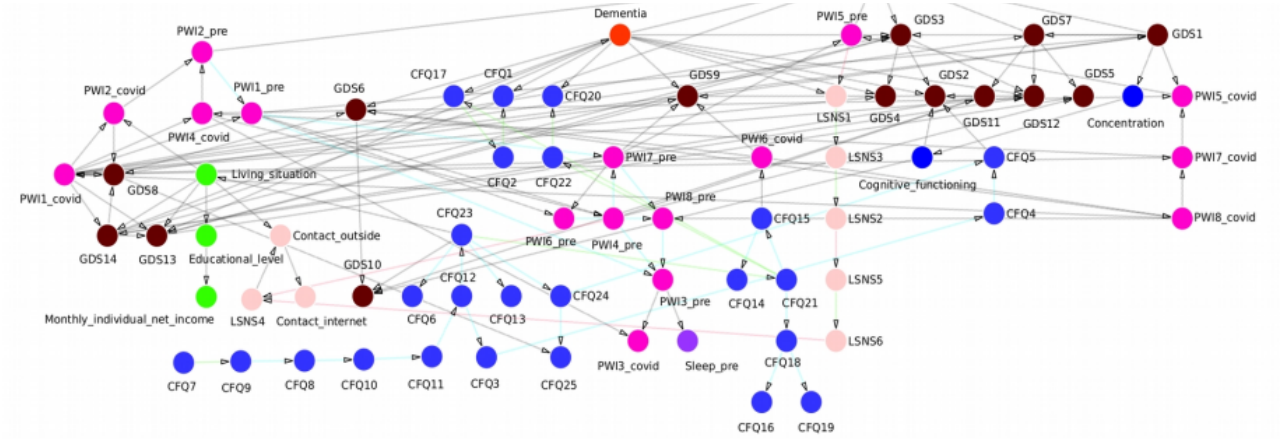


Figure 7: Expanded Item-level view of causal graph as shown in Figure 6.

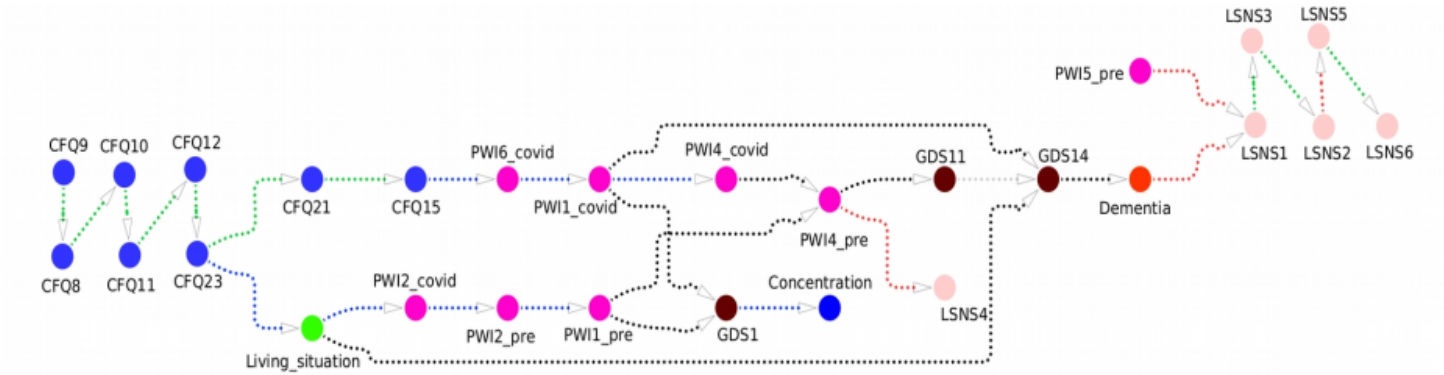


Figure 9: The graph represents the highlighted subgraph from Figure 8 which is the final item level abstraction of the coarse-grained view (Figure 5).

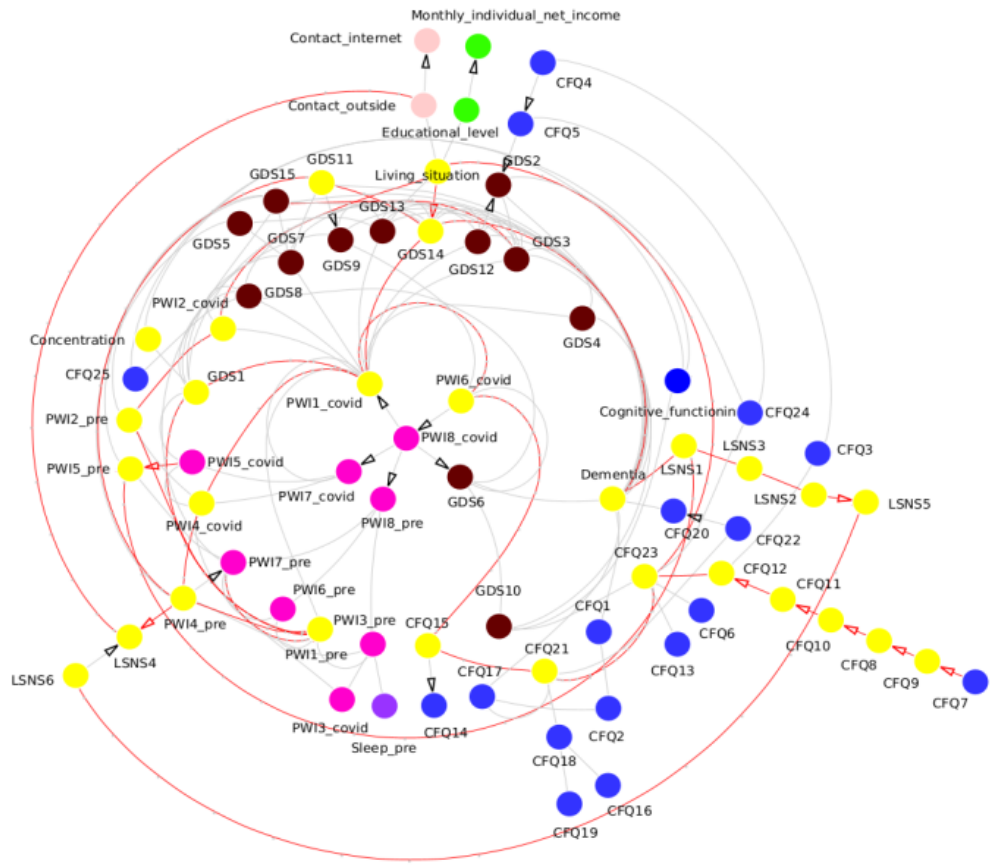


Figure 8: Expanded Item level view of causal graph with highlighted nodes (yellow) and edges (red) according to the graph betweenness metrics.

Summary

- We study the correlates and pathways related to behavior, cognition, social, health, environmental and demographic aspects, on wellbeing outcomes of older adults.
- Based on survey data on older adults (De Pue et al., 2021) from before and during the COVID-19, we investigate the factors and pathways at both quantitative and qualitative levels that impact mental health.
- We explored correlation-based bi-directional relationships and uni-directional causal relationships between the variables from multiple domains at coarse-grained as well as fine-grained level.
- The results show the dependence of major factors and pathways influencing mental health and wellbeing for the elderly during this period.
- The key contributions of our work are the use of correlation and causal analysis, and demonstrating the use of advanced methods in data science to derive better evidence-driven insights for public health and policy for the ongoing COVID-19 pandemic.

Way Forward

- Identifying key mental health and behavioral correlates and pathways on health and wellbeing outcomes in other contexts
- Demonstrating how data science, ML and AI can be used to further augment existing research methods in the areas of public health and policy, psychology, and other fields related to mental health.

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Thank You!