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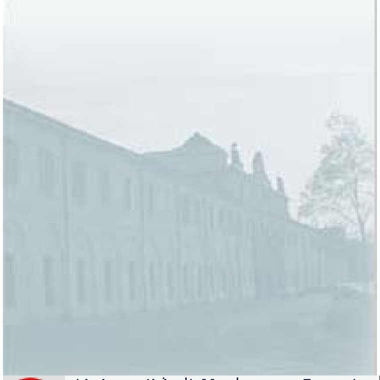

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Physical limitations, depressive symptoms and cognitive problems: exploring the complex structure of un-health among older people in Italy

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Abstract: Although health has always been a multidimensional concept, the research on older people's health has been mostly focused on specific dimension or disease, studied one at a time. The present work aims at understanding the complex associations among different indicators of older people's un-health in Italy. In order to reach this purpose, the work uses the Italian panel of the *Survey on Health, Ageing and Retirement in Europe* (SHARE) and explores the associations among a wide range of indicators of health problems by applying a series of Confirmative Factor Analysis. Differences between men and women and between a numbers of age groups of old people are systematically scrutinized. Finally, a SEM is carried out in order to map the inter-relations of the retained un-health dimensions across time. The preferred representation of the data is a nested model that identified one global factor, which related to all manifest indicators, and four residual factors that measured the specific experiences of physical impairment, cognitive problems, affective suffering and motivational difficulties. The findings confirm the invariance of the proposed nested latent structure across time and improve our understanding about how health dimensions are connected over time.

Introduction

Examining and measuring multidimensional aspects of health among older individuals is of primary importance. The study of multiple domains in the aged is by all means the way to gain a complete picture of their health. For most people aging is connected with decline of various kinds of human performance dimensions. Hence as people get older, they are increasingly exposed to physical, emotional, mental and sensorial troubles that lead to difficult situations.

The need to study whether an individual present multiple problems has been progressively more emphasized (Rockwood et al. 2000, Bortz 2002, Hogan et al. 2003). However, recent research has demonstrated that older people's health cannot be fully described by one global dimension. In fact, such a simple approach misses to describe all the complexity of its multifaceted structure (Brayne et al. 2001, Meinow et al. 2006). In consequence of that, it has become increasingly clear that studying elderly population needs approaches that allow for multiple measures of health to embrace all its complexity (Lafortune 2009, Hallerod 2009).

Structures of multidimensional health problems in the elderly Italian population have never been studied. There have only been a limited number of studies based on self-perceived valuations (Ongaro and Salvini 1995, Tsimbos 2009). The present study will attempt to disentangle the complex associations of a large number of un-health variables in the aged Italians.

The analysis will be drawn from the *Survey of Health, Ageing and Retirement in Europe* (*SHARE*) which provides detailed information on a large national scale (Borsh-Supan et al. 2005, 2008). The present analysis will use the first and second wave of the Italian sample, conducted respectively during the 2004 and 2007.

The study covered physical, emotional and cognitive domains that are extremely important for the individual in maintaining well-being (Nagi 1976, Fernandez-Ballesteros 2010). Here the use of a simple additive procedure that brings together disparate information in a single index of global impairment will be avoided. Instead, in order to conceptualize multidimensional health without losing its degrees of complexity factor analysis will be used.

The analysis will be conducted in several steps. Firstly, through explorative factor analysis we will attempt to have a picture of the latent representation of the observed variables. Subsequently, we will explore the hierarchical structures of the data via Confirmative Factor Analysis (CFA), separately for time 1 and 2. In so doing, several models that allow for different relationships between the manifest variables and various levels of latent factors will be tested. In order to evaluate the multifaceted structure of elderly population health, the generally agreed assumptions that indicators tap only in one latent factor and their error terms do not correlate with each other will be purposely relaxed (Gignac 2007). Thirdly, the analysis will attempt to understand if and to what extent the associations among the different indicators vary for age, gender and time. Finally, given that the structure of un-health is invariant across time, in order to evaluate the interrelations of un-health dimensions we will estimate a Structural Equation Model

(SEM), where each latent dimension at time 1 is considered causal for each latent dimension at time 2.

The paper opens with a discussion of the previous research and some theoretical considerations. Section 3 presents the data, the variables and the data analysis strategy. Section 4 proposes our empirical results, and finally conclusions are provided in Section 5.

Previous research

In the preamble of the World Health Organization (WHO) Constitution the founders defined health multidimensionally as “a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity” (WHO 1948). Over the half-century since the definition was set forth by WHO, many other contributions have improved the first vague proposition of health and developed more precise operational conceptualizations of its multidimensionality (Chen and Bryant 1975, Hansluwka 1985, Hunt et al. 1986, Bowling 1991, Salomon 2003). Currently, there is a wide consensus that a description of people’s health consists of a series of values indicating level on different domains (Coons et al. 2000, Murray et al. 2002).

The research on older people’s health has been mostly focused on specific dimension or disease, studied one at a time. Recently, original investigations have operationalized new concepts and perspectives of global health difficulties in the elderly (The Canadian Study of Health and Aging Working Group 2001). For example, in medical research the importance of “frailty” – when two or more problems are present together – has been well established (Rockwood et al. 2000, Bortz 2002). Initial investigations were based on small sample of patients in clinics and hospitals, subsequent studies have attempted to enlarge the field to a nationwide representative sample of older respondents. The first phenotypes of frail adults (Fried et al. 2001) were criticized to be comprised just of physical functionings (Hogan et al. 2003). The following definitions were expanded to include various domains of health, such as such mobility, psychological, cognitive and sensorial problems (e.g. Pel-Little et al. 2009).

While there is controversy concerning what aspects to consider, there is consensus that having health problems is a concept separated from chronic diseases. With this regard, several researches have showed that measures of frailty were associated with mortality independently of illnesses (Puts et al. 2005a, b, c). Salomon et al. (2003) suggested that not selecting medical condition as a domain of multidimensional health was in line with the spirit of the WHO Constitution (1948) and the advancements of the WHO family of classification systems[1]. That is, the diseases are not equated with health status itself, but conceptualized as a possible cause that makes more difficult achieving specific functionings or good level of global health (Salomon et al. 2003).

[1] They include International Classification of Disease and Related Health Problems (ICD) (WHO 1992), and the International Classifications of Functioning, Disability and Health (ICF) (WHO 2001).

Although frailty measures served as valid un-health predictors, they did not address the entire complexity of older people's situation. The majority of them used additive procedures and summed up all the information in a global index. However, recent research on population health suggested that elderly subgroups have singular pattern of presenting adverse outcomes (Lafortune et al. 2009). The differences in the accumulation of problems demonstrate large degree of human intricacy and warn against a simple and universal process of losing global level of health (Romoren and Blekeseaune 2003, Lunney et al. 2003). In fact, older people are highly heterogeneous in declining their status due to the variability and interdependence of the multiple health domains.

Thus, what has become increasingly clear is that elderly population health cannot be fully described by one global dimension (Brayne et al. 2001, Meinow et al. 2006,). That is, besides the presence of a significant and unequivocal group of older people who simultaneously suffer from global level of un-health, there are also individual who experience only specific problems. In view of that, it has been highly recommended to study older people's health and living condition using new approaches that can disclose all the complexity of its structure (Lafortune et al. 2009, Hallerod 2009).

Methods

Data

The data for the analysis were drawn from the publicly-released version of the *Survey of Health, Ageing and Retirement in Europe* (*SHARE* – Second Wave). What makes SHARE special is that it is the first cross-national and longitudinal study to explore topics related to work, retirement, mobility, disability, health care, psychological factors, cognitive function, aspects of daily life and socio-economic positions among non-institutionalized people aged 50 or more. The dataset also contains precious information about family composition and other individual socio-demographic characteristics (Borsh-Supan et al. 2005, 2008). The survey was conducted in a broad number of European countries (from Scandinavia to Mediterranean including a couple of Eastern nations). Based on probability samples in each participatory country, data were collected using computer-assisted personal interviews (CAPI) supplemented by two self-completion questionnaires (drop-off and vignettes). Our empirical analyses used the first and second wave of the Italian survey conducted respectively during the 2004 and 2007. The analysis sample was composed of 1761 observations.

Measures

The wide range of questions in SHARE allowed for a simultaneously analysis of a large number of un-health variables. Table 1 specifies the 27 examined indicators of impairment and their operational form. Each indicator was a dichotomous item in which a value of one represented the deprived situation. According to Nagi (1976), the variables were initially grouped into three categories: physical, emotional and cognitive impairment. Observe that this classification was tentative. It will guide the analysis but not determine the outcome.

Physical limitations concerned 10 indicators of problems with activities related to stamina, strength, arm and fine motor skills. All of the questions asked for a self-assessment and the respondents were invited to report the presence or the absence of a problem related to each task. The use of measures for people's abilities to lift or carry weight, ascend and descend stairs, walk, stoop, bend, or kneel, reach, and pick small objectives gained widespread success after appearing in works by Nagi (1969, 1976).

Recent debates on the measurement of physical performance have raised questions about whether strength, mobility and fine motor skills comprise one comprehensive domain or multiple related hierarchical factors. In Nagi (1976) all the indicators turned out to tap in one global physical dimension. According to the studies of Wolinsky and Jonshon (1992), Jonshon and Wolinsky (1993) and others (e.g. Fitzgerald et. al. 1993, Clark et. al. 1997) strength and mobility seemed to represent two high correlated factors: *lower* and *upper functioning*. The first one was comprised of such tasks as walking, stooping, kneeling and crouching. The upper functioning factor consisted of all the tasks related to reaching over one's head. Given the inconsistency in definitions of upper and lower body scales and the parsimony of a single scale, Long and Pavalko (2004) recently stated that there seemed to be little gained by separating physical skills into two domains.

Depressive *symptoms* concerned the 12 indicators that were validated as primary markers of a late-life depression during the EURODEP study (Prince et al. 1999a; b). Respondent at the survey were asked to report the presence or absence of each symptom. Since the beginning of the measure the EURODEP study (Prince 1999a, b) found that, across 14 European populations, the symptoms could be separated into two factors: *affective suffering* and *motivational problems*. The first factor included troubles with depression, sleeping, suicidal tendency, appetite, guilty, tearfulness, irritability and fatigue. Whereas, the second factor was comprised of the remaining four indicators: pessimism, lack of interest, lack of enjoyment and poor concentration. This latent structure has been confirmed in subsequent applications (Copeland et al. 2004, Castro-Costa et al. 2008)

Cognitive problems were measured using both fluid and crystallized abilities indicators (Dewey and Prince 2005b). The first ones concern performance in learning, remembering, processing new material and as well as reasoning abilities. The second group is entirely related to accumulated knowledge, such as word meaning and vocabulary size. SHARE included three fluid abilities indicators (*orientation, memory* and *recall*) and two crystallized skills markers (*verbal fluency* and *numeracy)*. They were all performance tests during which the respondents were asked to demonstrate their own abilities without the attendance of any proxy interviewee.

Each indicator had its original scale: the higher the score, the better the performance. Here, the markers were all re-coded into binary variables. A generally agreed criterion for relative cognitive impairment was followed (Dewey and Prince 2005b). A person was considered to be relatively deprived when she had a value less than 1.5 standard deviation below the mean.

In SHARE cognitive function was not evaluated with the assistance of any standard instrument. This means that the selected variables were not comparable in terms of internal consistency and measurement properties. Nevertheless, using similar indicators from an equivalent survey in the United States (HRS/AHEAD), Herzog and Wallace (1997) found two separated domains of cognitive function problems: *memory and mental status.* The first factor was comprised of problems with the immediate and delayed recall. The second one consisted of the remaining variables that related to orientation items, numerical knowledge and words recognition. Although the same structure has been replied in Ofstedal et al. (2005), these findings deserve attention. In particular, the high correlation between the two separate components warned against a clear interpretation of the proposed structure.

Analyses

A latent variable approach was used to examine the inter-relationships among the 27 indicators of un-health. Factor analysis provides a powerful tool to discover latent patterns, because it searches for joint variations in response to unobserved factors. These factors are obtained on the analysis of correlations matrix and they are linear combinations of the indicators, clustering those that are higher correlated. In computing them, each indicator is explicitly considered to contain a certain degree of measurement error, contributing only partially to each factor.

Because all the variables were dichotomous, a method of analysis for ordinal variables was used (Muthen and Muthen 2006). This involved estimating the correlation matrix using tetrachoric correlations and the parameters using weighted least-squared solutions with robust standard error and mean and variance-adjusted chi-squared (WLSMV).

Mplus software was used to conduct all the analyses. Firstly, Exploratory Factor analysis (EFA) was used to find a covariance structure in the data. Though EFA gave information about the type and the number of factors we should retain, it did not reveal much about the hierarchical structure of the underlying latent constructs. Hence, in order to uncover the best representation of the data, the second step of the analysis consisted in evaluating and comparing different theoretical models through Confirmative Factor Analysis (CFA). The models were initially estimated separately for time 1 and time 2.

According to Hu and Bentler (1999), a combination approach was used to assess model fit. Specifically, one baseline close-fit index (RMSEA) and two incremental close-fit indices (CFI and TLI) were chosen. Also in accordance with Hu and Bentler (1999), models are indicated as good fitting, when RMSEA is lower than 0.06 and the incremental close-fit indices are approximately 0.95 or larger. Since the main purpose was to test a series of models, a comparison strategy was also emphasized. According to Vanderberg and Lance (2000), a model is acknowledged to be practically superior to another one when the difference between TLI estimates was 0.01 or greater. This practical rule of improvement was used displacing the excessively powerful chi-square difference test (Gignac 2007).

In the third phase of the analyses, using a multigroup strategy we investigated whether the best-fitting structure of un-health was invariant across across age, gender and time. Separately for time 1 and 2, the factorial invariance across age and gender was investigated comparing the fit of a constrained multi-group model to the baseline. Similarly, factor invariance across time was evaluated comparing the fit of a freely estimated model to a fully constrained one.

In the last part of the analyses, we estimated a Structural Equation Model (SEM) where each latent dimension at time 1 was considered causal for each latent dimension at time 2. The coefficients between the same un-health dimensions for two different points of time are stability coefficients; whereas the coefficients between two different latent dimensions are regression coefficients.

Results

Exploratory factor analysis: uncovering the latent structure

Table 2 reported the prevalence of impaired situations for each indicator, respectively for time 1 and time 2. Depending of what type of problem was considered, large differences in prevalence were observed. Depressive symptoms were clearly more recurrent than physical difficulties and cognitive troubles.

The sample was divided arbitrarily into three age groups and we observed that occurrence of health problems dramatically increases with age. Turning to gender differences, the prevalence was often higher for women and most differences were large. Finally, the prevalence turned out to be quite homogenous across time. That was to be expected since differences cannot be explained after such a short period of time (2 years).

The first purpose was to scrutinize if and how the different un-health indicators related to each other and clustered together. A matrix of tetrachoric correlations was then generated and carefully inspected[2]. This first round of analysis supported a strong association among all the selected variables. As a consequence of that, all the indicators were kept for further investigations and the entire matrix was entered into an EFA.

Both at time 1 and time 2 the exploratory factor analysis of the tetrachoric correlations revealed that the first eigenvalue was substantially greater in magnitude than the remaining ones. Both for

[2] The matrix was not reported, but it wil be provided upon request.

time 1 and time 2 the first four eigenvalues were greater than 1.0 and the remaining ones were smaller than 1.0.

One rule for determining the number of factors is the scree method which looks for a large drop in the eigenvalues and then a trailing off of the subsequent values (Rummel 1970). Another thumb-rule is to retain the factors that have eigenvalues greater than 1.0. If so, the first method suggested a one factor solution, while the second recommended a four-factor structure.

Tables 3.1 and 3.2 presented the estimated factor loadings for a four-factor model after oblique (Promax) rotation, separately for time 1 and 2. The physical limitation items had strong loadings on one factor. The indicators that reflect troubles with cognitive function loaded robustly on the second factor. Thus, the first aspect measured to what degree people have problems with body activity, while the second one was about mental performance. In line with Long and Pavalko (2004), these preliminary findings seemed to reject the two scales solution for the physical dimension. Regarding cognitive aspects, the analysis refused a two-factor solution (Herzog and Wallace 1997, Ofstedal et al. 2005) and combined the entire information into one dimension.

Consistent with previous findings (Prince 1999a, b, Copeland 2004, Castro-Costa et al. 2008), depressive symptoms formed two separated domains. Indeed, the third factor was related to problems of loosing enthusiasm, motivation and optimism (pessimism, lack of enjoyment, lack of concentration and lack of interest); whereas the remaining problems of affection had strong loadings on the fourth factor.

Even though the four-factor structure of impairment was reasonable and visible, the factors themselves had moderately strong correlations. This made the interpretation less clear and obvious. The presence of a global dimension underlying the four domains could not be completely refused.

Confirmative factor analysis: testing different models

With the exploratory factor analysis there was sufficient evidence to suggest both a one factor representation and a four-factor solution of un-health. The correlation structure of the multiple compositions indicated the presence of a significant group of older people who simultaneously suffer from all the types of problems. At the same time, the correlation coefficients around 0.5 might suggest the presence of people who had problems just in one domain.

In view of these findings, in this second part of the analyses a set of three models was tested via CFA, separately for time 1 and 2. Firstly, a global factor model with all the 27 indicators specified to weight on a single general factor of un-health. Secondly, an oblique second-order factor model, in which the covariation link between the four factors – physical difficulties (Phys), cognitive problems (Cogn), affection symptoms (Affect) and motivational troubles (Motiv) - was modeled as a second-order general factor of un-health.

The third model was finally a nested-factor solution. Even though less extensively used, Gignac (2007) pointed out this structure as a valuable and practical alternative to study multi-dimensional phenomena. This model basically combined the general factor and the multi-factor model into a single solution. In our specific analysis it was comprised of one first-order general factor of un-health (*Glob*) and four nested residual factors, corresponding to physical limitations (*R_Phys*), cognitive problems (*R_Cogn*), affective symptoms (*R_Affect*) and motivational problems (*R_Motiv*).

In the nested model the generally agreed assumptions that indicators tap only in one dimension and their error terms do not correlate with each other are relaxed (Gignac 2007, Hallerod 2009). The global factor was directly related to the manifest variables, capturing the common variation in all the manifest variables. The residual variances of the observed indicators were freed to correlate and used to estimate the residual factors.

Unlike the previous ones, this last representation permitted to model un-health with a certain extent of complexity. The advantage of the nested-factor model was the possibility to test hypothesis pertaining to the nature of specific impairment domains, beyond the presence of a general un-health factor (Gignac 2007). Hence, what this model did appropriately perform was to separate people who experienced global impairment from those who had problems just in one domain.

The first model was fully described in Table 4.1 and 4.2. The factor weightings on the general factor ranged from 0.47 to 0.85 and were all statistically significant ($p > 0.01$). However, it was associated with close-fit indices values that indicated unacceptable level of fit (Table 7).

The second model was fully described in Table 5.1 and 5.2. Factor pattern coefficients were all statistically significant. The higher-order factor correlated robustly with all the four first-order latent variables. Based on the Hu and Bentler's (1999) cut-off criteria, the second-order model was associated with close-fit indices that indicated a good-fit (Table 7). Following Vanderberg and Lance's (2000) rule, this model was also practically better fitting than the previous one (ΔTLI=0.023).

The nested-factor model was fully reported in Table 6.1 and 6.2. It was clearly associated with close-fit indices that indicated excellent levels of fit (Table 7). Even if assuming that the four residual factors were uncorrelated, the model fitted the data practically better than the second-order model (ΔTLI=0.017).

This last representation corroborated in a convincing way that all the 27 indicators tapped into a common global un-health factor (*Glob*), but at the same time formed specific independent residual factors (R_Mob, R_Cogn, R_Affect and R_Motiv). It was therefore confirmed that some older people suffer from one type of impairment without reporting any other problem. In fact, the analysis showed that all the residual factors were well-defined and clearly interpretable.

The interpretation of the nested model was rather simple. The degree to which people simultaneously suffer from all the deprived situations was measured by *Glob*. People who were exposed to physical limitations but not to cognitive, affective and motivational problems scored on R_*Phys*. *R_Cogn* measured to what extent individuals who did not have physical and psychological problems had however some restrictions in the cognitive function. People who have some problems with affective suffering symptoms but otherwise did not report problems with the body, cognitive function and motivation scored on R_*Affect*. R_*Motiv* measure to what degree individuals who did not have other problems were only affected by motivational ones (poor concentration, lack of enjoinment, lack of interested and pessimism).

All the reported coefficients were statistically significant ($p > 0.01$), with the exception of "*loss of appetite*" which did not share any variance with the residual factors, independently of a general dimension of un-health. This means that those who reported such a symptom were also more likely to suffer from physical limitations, other depressive markers and cognitive problems. In view of these results, this analysis conferred to "*loss of appetite*" ("*diminution in desire for food*") a crucial role in explaining global level of un-health in the aged Italians.

Gender, age and time differences

Table 2 showed that women were more likely than men to suffer from health problems and that there was a higher prevalence of problems among the 'oldest old' (aged 76 or more). The question is whether these differences also mean that the relationships between the manifest variables varied between men and women and at different ages. Starting with men and women, a constrained two-group model was fitted. This model was estimated from two sub-samples, one for men and one for women. Because the model was constrained, it was assumed that the relationships among the various indicators are identical in both groups. If the observed differences between the two groups are large, the constrained model will fit the data poorly. In that case the model has to be relaxed, allowing for differences between groups. This would also mean that we have to conclude that women and men behave differently and therefore need to fit models that, at least partially, are specific to each sex.

There was, however, no need to relax the constrained two group model. It fitted the data well, and indeed the RMSEA indicated that the fit was better than for the single group model (see Table 7), because the degrees of freedom dramatically increased.

The same basic procedure was followed to examine age-group differences. First, a constrained two-group model was estimated to test for differences between the younger old (50 - 65 years) and the oldest old (66–99 years). Because the dividing age is arbitrary, one additional model was tested and a three group model was defined (50–60, 61–75 and 76–99 years). Table 7 showed that the constrained models fitted the data very well, which demonstrated that the basic relationships among distinguishable health problems are independent of age.

Thus, even though there were large differences in prevalence, the pattern was similar among men and women and at different ages. It was therefore appropriate to proceed using the results from the parsimonious nested single-group model.

We next moved to check the factorial invariance of the proposed un-health structure across time. Table 8 shows the results in terms of goodness of fit for two alternative models: a freely estimated model and a fully constrained model. In the first model the factor loadings and error terms were allowed to vary across time measurement; in the second one all the parameter estimates were set equal across time. The results showed that the fully constrained model was practically superior to the freely estimated solution (ΔTLI=0.011), which gave clear evidence to a time invariance of the proposed un-health structure.

Interrelations of un-health dimensions across time

We finally moved to use the longitudinal information of the sample. It was showed that various health problems were related to each other at a moment in time, but it is at least as important to sort out how problems inter-relate over time. We then mapped the causal relationships among different un-health dimensions through Structural Equation Modelling (SEM) (Bollen 1989). Each retained latent un-health factor at time 1 was assumed to be causal for its respective at time 2. The time 1 latent dimensions also influenced the other time 2 dimensions, stepwise. The results were displayed in Table 9.

The coefficients between the same un-health dimensions for two different points of time are stability coefficients, whereas the coefficients between two different latent variables are standardized regression coefficients, which show the deviation from the average in the endogenous latent variable due to a deviation from the mean of 1% in the exogenous latent variable.

The highest stability coefficient was for Glob (0.91). There were also significant influences from R_Phys and R_Cogn at time 1 on Glob at time 2. That is, people with physical and cognitive residual problems at time 1 were more likely to be globally un-healthy at time 2. On the contrary, residual affective and motivational difficulties at time 1 did not share any significant association with global problems at time 2. These results suggested that both physical and cognitive difficulties had an important role in driving people from one to multiple health problems.

Residual physical problems had a very high stability coefficient (0.88). There were no significant influences from other un-health dimensions on R_Phys at time 2. This was to be expected since the latent inclination towards physical health cannot be explained with a short relatively two period framework.

Residual cognitive problems had a high stability coefficient (0.82). Motivational residual problems at time 1 had a positive influence on residual cognitive problems at time 2. This was to be expected since motivational troubles might often overlap and drive people into cognitive problems.

Both the residual affective dimension and the residual motivational dimension had a relatively lower stability coefficient (0.75 and 0.78 respectively). This was probably due to the volatility and subjectivity of the psychosocial measures. Finally, both these factors seemed to be quite associated over time.

Conclusions

Starting from the preamble of the WHO Constitution (1948) it has been strongly pointed out that a multi-dimensional perspective is always required when studying health. The research community and policy makers have paid progressively more attention to the implications of the accumulation and coexistence of health problems, especially in the older people. Nevertheless, it has been increasingly emphasized that studying elderly population should involve approaches that allow for multiple measures of health to embrace its complexity.

The present study has reported the findings of an analysis of the association among a wide number of un-health variables in the Italians aged 50 or more. Using nationally representitative data, we examined 27 indicators that reflect troubles in domains important for the individual in maintaining well-being: physical condition, emotional status and cognitive function.

Explorative factor analysis (EFA) gave plausibility to various latent solutions of un-health. However, confirmative factor analyses (CFA) revealed that a nested model was the best and clearest representation of the data. This solution permitted to describe health with a certain amount of complexity. One global aspect of un-health that related to all the 27 indicators was generated. At the same time, there was evidence to suggest the existence of four residual dimensions, which measured the exclusive presence of physical (R_Phys), cognitive (R_Cogn), affective (R_Affect) and motivational problems (R_Motiv).

The existence of a global latent variable indicated that the different problems were inclined to accumulate and coexist into one dimension. At the same, the residual factors pointed out the presence of significant sub-groups of people who had problems just in one domain. R_*Phys* showed that some people were exposed to physical limitations without suffering from cognitive, affective and motivational problems. *R_Cogn* revealed the occurrence of individuals who did not have physical and psychological troubles, but otherwise presented restrictions in the cognitive function. *R_Affect* corroborated the existence of people who had some problems with affective suffering symptoms (depression, irritability, restlessness etc.), but did not report any deprivation with physical skills, cognitive function and motivation. Finally, the residual factor R_*Motiv* showed that some individuals had motivational problems (pessimism, lack of interest and lack of enjoyment), even if were not affected by other troubles, included usual affective suffering symptoms.

The findings illustrated in a convincing way that the selected indicators can tap in more than one factor and the residual variance of the manifest variables can be accurately used to depict a complex structure of older people's health. Nevertheless, the results showed that some manifest variables cannot share any co-variance with the residual domains, independently of the global measure. In fact, "*loss of appetite"* had strong loadings on the overall dimension, but was not statistically significant associated with the respective residual factors. It was inferred that this indicator had an important role in explaining global level of un-health. That is, aged Italians who experienced "*loss of appetite"* (diminution in desire for food) were highly more likely to suffer from other problems concerning physical, emotional and mental performance.

The prevalence of health problems differs substantially between men and women and by age. To determine whether the relationship between health problems differs for these groups, a series of multi-group models was fitted. The results showed that regardless of large differences in prevalence, the basic relationship between health problems appeared to be the same among men and women and at different ages. Using the available information of the longitudinal sample, the proposed latent structure of un-health turned out to be also invariant across time.

One advantage of the CFA method is that it produces factors that are empirically valid measures of distinctive aspects of people's health. Given the invariance of the nested latent structure across time, a SEM was finally put forward to study the interrelationships of the different un-health dimensions over time. Global un-health, residual physical difficulties and residual cognitive problems presented high stability coefficients. Residual affective symptoms and residual motivational troubles turned out to be comparatively less stable and overlapped over time. Finally, global un-health at time 2 was consistently predicted by residual physical difficulties and residual cognitive problems at time 1.

These findings cannot be considered the final stage of our analysis and will need further validations in other countries. Cross-cultural comparisons were then left for future investigations. The analysis offered a complete understanding of the complex structure of aged Italians' un-health. The findings provided sufficient evidence to reject simple descriptions of older situations based on merely one global domain. It was also abundantly well documented that the proposed nested structure of un-health was invariant across age, gender and time. It turned out to be also very needful to understand how health problems inter-related over time.

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Tables

Table 1. Indicator of un-health

Indicator	Definition and operational form
Walk	Has problems walking 100 meters (0 = no; 1 = yes)
Sit	Has problems **sitting** for about two hours (0 = no; 1 = yes)
Get up	Has problems **getting up** from a chair after sitting for long periods (0 = no; 1 = yes)
Climb several flights	Has problems **climbing several flights** of stairs without resting (0 = no; 1 = yes)
Climb one flight	Has problems **climbing one flight** of stairs without resting (0 = no; 1 = yes)
Stoop	Has any problems **stooping, kneeling, or crouching** (0 = no; 1 = yes)
Reach up	Has problems **reaching or extending** your arms above shoulder level (either arms) (0 = no; 1 = yes)
Pull	Has problems **pulling or pushing** large objects like a living room chair (0 = no; 1 = yes)
Lift weights	Has problems **lifting or carrying weights** over 5 kilos, like a heavy bag of groceries? (0 = no; 1 = yes)
Pick	Has problems **picking up** a small coin from a table (0 = no; 1 = yes)
Sadness/Depression	In the last month has been **sad or depressed** (0 = no; 1 = yes)
Pessimism	Does not have **any hopes** for the future (0 = no; 1 = yes)
Suicidal tendency	In the last month has felt that he or she would **rather be dead** (0 = no; 1 = yes)
Guilty	Tends to **blame** himself or herself and **fells guilty** (0 = no; 1 = yes)
Trouble sleeping	Recently has had **troubles sleeping** (0 = no; 1 = yes)
Lack of interest	In the last month has lost **interest in things** (0 = no; 1 = yes)
Irritability	Recently has been **irritable** (0 = no; 1 = yes)

Loss of appetite	Suffers from diminution in desire for food (0 = no; 1 = yes)
Fatigue	In the last month has had **too little energy** to do the things you wanted to do (0 = no; 1 = yes)
Poor concentration	Suffers from difficulty in concentrating on entertainment or reading (0 = no; 1 = yes)
Lack of enjoyment	Recently has not **enjoyed** doing anything (0 = no; 1 = yes)
Tearfulness	In the last month has often **cried** (0 = no; 1 = yes)
Orientation in time	Scored less than 1.5 standard deviation below the mean in the **orientation test**: day of the month, month, year and day of the week. Original values from 0 to 4. (0 = no; 1 = yes)
Memory	Scored less than 1.5 standard deviation below the mean in the **immediate memory test**: number of words the individual can instantaneously recall from a list of 10 items. Original values from 0 to 10. (0 = no; 1 = yes)
Recall	Scored less than 1.5 standard deviation below the mean in the **recall memory test**: number of words the individual can recall from a list of 10 items after a certain delay of time. Original values from 0 to 10. (0 = no; 1 = yes)
Verbal Fluency	Scored less than 1.5 standard deviation below the mean in the **verbal fluency test:** number of different animals the respondent can name within one minute. Original values from 0 to 80. (0 = no; 1 = yes)
Numeracy	Scored less than 1.5 standard deviation below the mean in the **numerical knowledge test**: four simple arithmetic calculations. Original values from 0 to 4. (0 = no; 1 = yes)

Table 2. Prevalence of un-health by gender and age groups
Left: Time 1 – Right: Time 2

	Gender		Age groups (years)			Total
Indicator	Men	Women	50 – 60	61 – 75	76 – 99	
			Percentages			
Walk	6.8 – 8.5	12.8 – 15.6	5.5 – 4.1	9.5 – 11.2	29.2 – 30.4	10.2 – 12.5
Sit	8.3 – 7.3	13.3 – 14.7	8.9 – 8.7	11.2 – 11.7	19.3 – 15.6	11.1 – 11-7
Get up	12.2 – 13.8	22.3 – 24.1	11.6 – 11.3	19.5 – 20.6	31.6 – 32.7	17.8 – 19.5
Climb several	21.1 – 28.4	35.6 – 40.3	21.0 – 21.7	33.5 – 35.8	55.6 – 57.8	31.0 – 35.3
Climb one flight	8.3 – 13.5	17.5 – 19.5	8.1 – 3.8	13.5 – 17.4	32.3 – 38.5	13.6 – 16.9
Stoop	23.1 – 29.3	36.4 – 46.6	24.5 – 23.6	34.1 – 40.1	55.8 – 61.2	32.8 – 38.8
Reach up	5.4 – 7.5	11.3 – 14.3	5.3 – 4.7	8.4 – 11.0	19.8 – 23.3	8.8 – 11.3
Pull	5.1 – 9.6	11.8 – 15.3	3.3 – 4.9	9.6 – 14.3	24.7 – 29.2	8.9 – 14.1
Lift weights	9.8 - 13.2	14.6 – 24.4	10.4 – 13.1	19.5 – 26.4	31.4 – 41.8	12.5 – 19.2
Pick	2.7 – 2.9	5.4 – 5.6	1.1 – 1-1	4.6 – 4.9	13.5 – 15.2	4.2 – 5.1
Sadness	31.4 – 32.3	52.3 – 52.0	45.4 – 40.8	41.4 – 44.8	47.7 – 45.6	43.3 – 43.9
Pessimism	19.5 – 16.9	21.6 – 17.6	15.3 – 10.7	21.3 – 17.6	34.9 – 27-8	20.5 – 17.3
Suicidal tendency	4.6 – 5.5	7.5 – 8.2	4.5 – 4.3	6.3 – 6.6	12.2 – 12.7	6.2 – 7.1
Guilty	8.8 – 11.7	8.9 – 11.0	8.6 – 13.1	9.9 – 11.8	8.4 – 7.1	8.8 – 11.3
Trouble sleeping	24.0 – 21.5	38.2 – 39.4	31.1 – 28.8	32.5 - 31.9	36.9 – 36.0	32.8 – 31.7
Lack of interest	8.7 – 11.7	12.6 – 16.8	9.8 – 12.6	10.2 – 14.3	17.5 – 19.1	11.0 – 14.7
Irritability	34.4 – 32.9	39.6 – 38.1	40.6 – 36.8	34.5 – 35.8	40.3 – 34.5	37.4 – 35.9
Loss of appetite	4.5 – 6.7	8.9 – 10.1	4.0 – 5.6	7.3 – 8.0	17.5 – 15.3	7.2 – 8.6
Fatigue	26.5 – 25.1	41.3 – 40.9	32.6 – 26.2	35.0 – 35.6	41.3 – 43.9	34.9 – 34.7
Poor concentration	25.6 – 26.1	33.3 – 33.2	25.6 – 21.9	29.7 – 29.9	47.1 – 44.8	30.1 – 30.2
Lack of enjoyment	22.1 – 22.2	28.7 – 25.2	23.5 – 21.2	24.7 – 20.9	38.3 – 36.6	25.8 – 23.5
Tearfulness	12.7 – 14.8	37.8 – 38.8	29.2 – 25.3	24.5 – 28.7	27.7 – 30.7	26.4 – 28.0
Orientation in time	15.1 – 17.5	12.5 – 14.7	9.1 – 9.2	14.5 – 15.1	29.2 – 30.1	13.2 – 15.5
Memory	6.3 – 6.2	5.2 – 5.9	1.9 – 1.6	5.8 – 4.9	18.0 – 16.2	5.7 – 5.5
Recall	16.6 – 15.1	14.3 – 13.8	8.5 – 6.2	16.2 – 14.3	35.8 – 30.7	15.7 – 14.3
Verbal fluency	2.4 – 3.0	5.1 – 4.8	1.6 – 0.8	3.9 – 2.9	8.7 – 8.5	3.6 – 3.4
Numeracy	9.5 – 11.4	5.0 – 5.5	3.5 – 3.9	11.9 – 10.7	26.7 – 27.7	10.4 – 11.8

Table 3.1 Exploratory factor analysis: factor loadings for a four-factor model - promax rotation (time 1)

Indicator	Factor I	Factor II	Factor III	Factor IV
Walk	0.82	.	.	.
Sit	0.68	.	.	.
Get up	0.82	.	.	.
Climb several flight	0.85	.	.	.
Climb one flight	0.78	.	.	.
Stoop	0.84	.	.	.
Reach up	0.74	.	.	.
Pull	0.82	.	.	.
Lift weights	0.80	.	.	.
Pick	0.68	.	.	.
Sad/Depressed	.	.	.	0.85
Pessimism	.	.	0.63	.
Suicidal tendency	.	.	.	0.55
Guilty	.	.	.	0.52
Troubles sleeping	.	.	.	0.56
Lack of interest	.	.	0.62	.
Irritability	.	.	.	0.56
Loss of appetite	.	.	.	0.67
Fatigue	.	.	.	0.53
Poor concentration	.	.	0.68	.
Lack of enjoyment	.	.	0.66	.
Tearfulness	.	.	.	0.79
Orientation in time	.	0.95	.	.
Memory	.	0.78	.	.
Recall	.	0.77	.	.
Verbal Fluency	.	0.58	.	.
Numeracy	.	0.59	.	.

Promax factor correlations

	I	II	III	IV
I	1			
II	0.48	1		
III	0.51	0.36	1	
IV	0.53	0.45	0.56	1

Note: the table has no zero. The factor loadings with value less than |0.35| have been not reported for ease of comparison.

Table 3.2 Exploratory factor analysis: factor loadings for a four-factor model - promax rotation (time 2)

Indicator	Factor I	Factor II	Factor III	Factor IV
Walk	0.81	.	.	.
Sit	0.70	.	.	.
Get up	0.83	.	.	.
Climb several flight	0.87	.	.	.
Climb one flight	0.79	.	.	.
Stoop	0.86	.	.	.
Reach up	0.77	.	.	.
Pull	0.86	.	.	.
Lift weights	0.83	.	.	.
Pick	0.71	.	.	.
Sad/Depressed	.	.	.	0.83
Pessimism	.	.	0.66	.
Suicidal tendency	.	.	.	0.58
Guilty	.	.	.	0.56
Troubles sleeping	.	.	.	0.57
Lack of interest	.	.	0.64	.
Irritability	.	.	.	0.59
Loss of appetite	.	.	.	0.69
Fatigue	.	.	.	0.55
Poor concentration	.	.	0.71	.
Lack of enjoyment	.	.	0.64	.
Tearfulness	.	.	.	0.81
Orientation in time	.	0.93	.	.
Memory	.	0.80	.	.
Recall	.	0.78	.	.
Verbal Fluency	.	0.60	.	.
Numeracy	.	0.58	.	.
Promax factor correlations				
	I	II	III	IV
I	1			
II	0.50	1		
III	0.56	0.41	1	
IV	0.58	0.48	0.60	1

Note: the table has no zero. The factor loadings with value less than |0.35| have been not reported for ease of comparison.

Table 4.1 Standardized parameter estimates (WLSMV) for one-factor solution (time 1)

Indicator	Glob
Walk	0.85
Sit	0.69
Get up	0.78
Climb several flights	0.77
Climb one flight	0.83
Stoop	0.78
Reach up	0.77
Pull	0.87
Lift weights	0.84
Pick	0.72
Orientation in time	0.63
Memory	0.63
Recall	0.63
Verbal Fluency	0.64
Numeracy	0.68
Sad/Depressed	0.65
Suicidal tendency	0.54
Guilty	0.53
Troubles sleeping	0.64
Irritability	0.55
Loss of appetite	0.74
Fatigue	0.79
Tearfulness	0.64
Pessimism	0.6
Lack of interest	0.69
Lack of enjoyment	0.58
Poor concentration	0.63

Note: all the parameter estimates were statistically significant ($p < 0.01$)

Table 4.2 Standardized parameter estimates (WLSMV) for one-factor solution (time 2)

Indicator	Glob
Walk	0.86
Sit	0.71
Get up	0.80
Climb several flights	0.79
Climb one flight	0.85
Stoop	0.77
Reach up	0.76
Pull	0.89
Lift weights	0.85
Pick	0.74
Orientation in time	0.66
Memory	0.61
Recall	0.65
Verbal Fluency	0.62
Numeracy	0.70
Sad/Depressed	0.66
Suicidal tendency	0.57
Guilty	0.55
Troubles sleeping	0.66
Irritability	0.57
Loss of appetite	0.76
Fatigue	0.81
Tearfulness	0.63
Pessimism	0.62
Lack of interest	0.71
Lack of enjoyment	0.60
Poor concentration	0.65

Note: all the parameter estimates were statistically significant ($p < 0.01$)

Table 5.1 Standardized parameter estimates (WLSMV) for a second-order factor solution

(time 1)

Indicator	Glob	Phys	Cogn	Affect	Motiv
Walk		0.88			
Sit		0.75			
Get up		0.82			
Climb several flights		0.81			
Climb one flight	0.87	0.86			
Stoop		0.81			
Reach up		0.80			
Pull		0.89			
Lift weights		0.88			
Pick		0.79			
Orientation in time			0.73		
Memory	0.62		0.84		
Recall			0.71		
Verbal Fluency			0.75		
Numeracy			0.87		
Sad/Depressed				0.79	
Suicidal tendency				0.65	
Guilty				0.51	
Troubles sleeping	0.69			0.70	
Irritability				0.64	
Loss of appetite				0.79	
Fatigue				0.89	
Tearfulness				0.75	
Pessimism					0.75
Lack of interest	0.86				0.81
Lack of enjoyment					0.63
Poor concentration					0.83

Note: all the parameter estimates were statistically significant ($p < 0.01$)

Table 5.2 Standardized parameter estimates (WLSMV) for a second-order factor solution (time 2)

Indicator	Glob	Phys	Cogn	Affect	Motiv
Walk		0.90			
Sit		0.77			
Get up		0.83			
Climb several flights		0.82			
Climb one flight	0.88	0.85			
Stoop		0.80			
Reach up		0.82			
Pull		0.91			
Lift weights		0.89			
Pick		0.81			
Orientation in time			0.74		
Memory	0.63		0.86		
Recall			0.73		
Verbal Fluency			0.73		
Numeracy			0.88		
Sad/Depressed				0.81	
Suicidal tendency				0.64	
Guilty				0.53	
Troubles sleeping	0.70			0.72	
Irritability				0.65	
Loss of appetite				0.77	
Fatigue				0.91	
Tearfulness				0.73	
Pessimism	0.85				0.73
Lack of interest					0.83
Lack of enjoyment					0.65
Poor concentration					0.82

Note: all the parameter estimates were statistically significant ($p < 0.01$)

Table 6.1 Standardized parameter estimates (WLSMV) for a nested-factor solution (time 1)

Indicator	*Glob*	*R_Phys*	*R_Cogn*	*R_Affect*	*R_Motiv*
Walk	0.74	0.52			
Sit	0.61	0.40			
Get up	0.63	0.49			
Climb several flight	0.65	0.55			
Climb one flight	0.70	0.47			
Stoop	0.64	0.55			
Reach up	0.68	0.47			
Pull	0.70	0.49			
Lift weights	0.69	0.50			
Pick	0.61	0.42			
Orientation in time	0.52		0.39		
Memory	0.54		0.65		
Recall	0.51		0.56		
Verbal Fluency	0.53		0.52		
Numeracy	0.64		0.47		
Sad/Depressed	0.58			0.69	
Suicidal tendency	0.53			0.43	
Guilty	0.51			0.39	
Troubles sleeping	0.62			0.46	
Irritability	0.53			0.44	
Loss of appetite	0.75			**0.05**	
Fatigue	0.69			0.45	
Tearfulness	0.62			0.49	
Pessimism	0.54				0.49
Lack of interest	0.70				0.57
Lack of enjoyment	0.57				0.47
Poor concentration	0.66				0.40

Note: parameter estimates in red were not statistically significant ($p > 0.10$). The others were all statistically significant ($p < 0.01$)

Table 6.2 Standardized parameter estimates (WLSMV) for a nested-factor solution (time 2)

Indicator	*Glob*	*R_Phys*	*R_Cogn*	*R_Affect*	*R_Motiv*
Walk	0.76	0.50			
Sit	0.63	0.42			
Get up	0.65	0.51			
Climb several flight	0.67	0.53			
Climb one flight	0.72	0.48			
Stoop	0.66	0.54			
Reach up	0.68	0.45			
Pull	0.72	0.51			
Lift weights	0.71	0.49			
Pick	0.62	0.41			
Orientation in time	0.53		0.40		
Memory	0.52		0.63		
Recall	0.52		0.55		
Verbal Fluency	0.51		0.54		
Numeracy	0.62		0.45		
Sad/Depressed	0.60			0.67	
Suicidal tendency	0.55			0.41	
Guilty	0.49			0.41	
Troubles sleeping	0.60			0.43	
Irritability	0.55			0.45	
Loss of appetite	0.73			**0.07**	
Fatigue	0.71			0.47	
Tearfulness	0.63			0.51	
Pessimism	0.55				0.47
Lack of interest	0.71				0.55
Lack of enjoyment	0.58				0.48
Poor concentration	0.69				0.38

Note: parameter estimates in red were not statistically significant ($p > 0.10$). The others were all statistically significant ($p < 0.01$)

Table 7. The fit of the confirmatory factor analysis models of un-health (Time 1 and Time 2)

	Time 1			Time 2		
Model specification	RMSEA	CFI	TLI	RMSEA	CFI	TLI
One-factor model	0.077	0.913	0.932	0.072	0.916	0.935
Second-order factor model	0.044	0.947	0.966	0.040	0.952	0.968
Nested factor model	0.035	0.959	0.982	0.032	0.963	0.985
Nested constrained two group model: gender	0.034	0.960	0.983	0.031	0.964	0.985
Nested constrained two group model: age 50-65/66-99	0.035	0.959	0.983	0.030	0.965	0.987
Nested constrained three group model: age 50-60/61-75/76-99	0.034	0.960	0.984	0.031	0.964	0.985

Table 8. Time invariances tests for the nested model of un-health

Model specification	RMSEA	CFI	TLI
Freely estimated model	0.039	0.948	0.971
Fully constrained model	0.035	0.961	0.982

Table 9. Standardized parameter estimated for a stability model of un-health

	Glob_t2	R_Mob_t2	R_Cogn_t2	R_Affect_t2	R_Motiv_t2
Glob_t1	0.91***	-	-	-	-
R_Mob_t1	0.13***	0.88***	0.01	0.05	0.02
R_Cogn_t1	0.11**	0.05	0.82***	0.03	0.04
R_Affect_t1	0.02	0.01	-0.01	0.73***	0.09*
R_Motiv_t1	0.02	0.03	0.06***	0.10**	0.75***

Note: Significance levels: * p<0.1, ** p<0.05, *** p<0.01