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Usefulness of the BRIEF-Multidimensional Prognostic Index (BRIEF-MPI) to identify older adults' healthcare needs to be addressed with a Personalized Prevention Program in general practice: preliminary data from the PrimaCare_P3 study

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Abstract

Background In Europe around 40% of people aged ≥ 65 years are affected by multiple non-communicable chronic diseases (NCDs). The Comprehensive Geriatric Assessment (CGA) showed its usefulness in early identifying healthcare needs of older people with NCDs to develop a care plan to meet these needs. PrimaCare_P3 study aims at assessing healthcare needs of older people referring to their general practitioners (GPs) to plan a personalised prevention programme (PPP) based on the results of the CGA-based short version of the Multidimensional Prognostic Index (BRIEF-MPI).

Methods 612 participants with at least one NCDs were included in the intervention group (IG) by twenty GPs from four geographical areas. Functional, cognitive, nutritional, social and co-habitation conditions, co-morbidity, polytherapy, and vaccination status were assessed. Following the CGA-based BRIEF-MPI assessment, participants were provided with a PPP, consisting of targeted indications and interventions including prescribed specialistic examinations, if needed.

Results Polytherapy and nutritional status were the most impaired domains with 59% of participants showing severe polypharmacy requiring a deprescribing strategy on GP's judgement while 25% of participants being malnourished or overweight/obese. Moreover, 22% of participants showed cognitive impairment requiring intervention, 18.5% were at risk of social isolation and/or loneliness, and 16.5% had some form of functional impairments in activities of daily

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living. Missing vaccinations according to the National Vaccination Prevention Plan (PNPV) were anti-influenza (34%), anti-COVID-19 (45%), anti-pneumococcus (74%), anti-herpes zoster (89%).

Conclusions These data suggest that the CGA-based BRIEF-MPI assessment could effectively identify older adults' healthcare needs to be addressed with a PPP in general practice setting.

Trial registration Registered on clinicaltrials.gov, NCT06224556, 05-01-2024.

Introduction

In 2016, the prevalence of non-communicable chronic diseases (NCDs) worldwide was reported as 91.034 per 100.000 inhabitants [1]. In Italy, about 24 million people of any age class have one or more NCDs, and of this more than 85% are people aged 75 years or older [2]. According to recent evidence [3], NCDs might have pathophysiological pathways in common with "accelerated" aging, occurring as a gradual rise in multidimensional frailty, which is a decline in functioning in multiple physiological systems with a resultant elevated vulnerability to stressors associated to high risk for negative health outcomes due to the loss of harmonic interaction between multiple domains/dimensions (including genetic, biological, functional, cognitive, psychological, and socioeconomic domain) that ultimately lead to homeostatic instability [4].

An essential element of modern geriatric medicine is the Comprehensive Geriatric Assessment (CGA) [5], which is the gold standard for assessing multidimensional frailty and obtaining a general picture of the older person's health profile. Being considered as an extremely useful tool for the assessment of older people [6], the CGA enables: (i) the early identification of various needs in older adults [7]; (ii) the development of tailored interventions based on compromised domains that carry a higher risk of adverse outcomes; and (iii) to track changes in multidimensional domains. Recent meta-analysis and umbrella reviews reported that the CGA in primary care and community-dwelling older people with NCDs is effective in addressing physical frailty [7] and the risk of unplanned hospital admissions [8] as well as in improving Health-Related Quality of Life (HRQoL) and self-management of chronic conditions [9, 10].

The Multidimensional Prognostic Index (MPI) [11] is a validated prognostic tool based on information collected through a standard CGA. Several multicenter studies demonstrated that the MPI is very accurate and calibrated to predict several negative health outcomes of older people, including institutionalization, hospitalization, and mortality [12]. Initially developed and validated in the hospital setting [11], the MPI has been subsequently validated and widely employed in the community-dwelling [13], general practice [14], nursing home residents [15], and at an older population level [16, 17]. The recent Italian Guideline on CGA [18] for the older people recommended using CGA in general practice and primary care setting to reduce unplanned hospitalizations. Among the CGA-based tools used to predict negative outcomes, i.e. mortality, and facilitating the development of personalized prevention programs (PPP) in older people, the Guideline also included the MPI. Nevertheless, no study has yet explored whether the use of the short version of the MPI (BRIEF-MPI) is useful for identifying the needs of older people in the primary care setting and to develop and carry out a PPP.

Recently, in the context of the NextGenerationEU National Plan for Recovery and Resilience (PNRR) program, the multicentre PrimaCare_P3 study was designed to assess the efficacy of a multicomponent PPP, based on the BRIEF-MPI (Intervention Group, IG), in older people with NCDs referring to primary care to improve health outcomes (i.e. unplanned hospitalizations, outpatient visits, and institutionalizations) compared to usual care (Control Group, CG) [19].

The present article reports baseline data from the IG, i.e. the clinical and functional multidimensional information, gathered by General Practitioners (GPs) through the BRIEF-MPI, to identify the healthcare needs for planning the PPP. To the best of our knowledge, this is the first project aiming at systematically carrying out a standardized CGA-based BRIEF-MPI to older people referring to their GPs with the final objective of planning a PPP based on the healthcare needs as emerged from the multidimensional evaluation. The added value of the study is the development and the deployment of a PPP grounded on the results of the CGA-based BRIEF-MPI in primary care setting.

Methods.

The PrimaCare_P3 project

The PrimaCare_P3 is a NextGenerationEU project (PNRR-MAD-2022-12376781) involving the Italian National Institute of Health (Rome, Italy), Paolo Giaccone University Hospital (Palermo, Italy), Aldo Moro University of Bari (Bari, Italy) and coordinated by Galliera Hospital (Genoa, Italy). The study was approved by the Local Ethical Committee (15-11-2023, n° 678/2022, registered on clinicaltrials.gov, NCT06224556, 05-01-2024) and conducted following the Declaration of Helsinki.

Study population

GPs selected on a voluntary basis from four different geographical areas in Italy, were randomized in clusters and assigned to IG or CG. Each GP identified a list of patients aged ≥ 65 years reporting at least one NCD. From these lists, patients were randomly selected for inclusion and assigned to the IG or CG based on their GP's allocation. GPs from the CG were blinded from the activities included in the intervention. A total of 1.223 patients were enrolled: 612 in the IG, and 611 in the CG.

The description of the overall study design and protocol of the project has been published elsewhere [19]. In the present article, we reported solely data on the 612 patients included in the IG, who underwent CGA using the BRIEF-MPI and were assigned a CGA-based PPP.

Assessment: the BRIEF-MPI

The BRIEF-MPI (see Supplementary Materials, Table S1) assesses the same eight domains as the standard version of the MPI, but with a lower number of items, with a comparable accuracy [20] and an Area Under the ROC Curve of 0.92 of agreement compared to standard full version of the MPI, but taking less time (around five minutes) for its administration. It was previously validated with good reliability in different settings (outpatient, hospital, and emergency departments [20–22]), and as the standard version is both an assessment and a prognostic tool with good predictive capacities of different negative outcomes [20, 23]. Following a CGA approach, the BRIEF-MPI [20] assesses: (1) Activities of Daily Living (ADL) [24], (2) Instrumental Activities of Daily Living (IADL) [25], (3) mobility (MOB) (Barthel Index Mobility Scale) [26], (4) cognition (Short Portable Mental Status Questionnaire (SPMSQ) [27], (5) nutritional status (Mini-Nutritional Assessment - Short Form (MNA-SF) [28], (6) number of diseases requiring chronic therapies, (7) number of medications, and (8) cohabitation status. The BRIEF-MPI allows to define a level of risk related to each domain (0 = mild; 0.5 = moderate; 1 = severe), and, through a specific algorithm, provides a global score ranging from 0.0 (lowest risk) to 1.0 (highest risk of multidimensional frailty), identifying three classes of risk, i.e. MPI class 1 (score between 0.00 and 0.33 = low); MPI class 2 (score between 0.34 and 0.66 = moderate); MPI class 3 (score ≥ 0.67 = high).

The BRIEF-MPI application for desktop PC can be downloaded for free from the website [29] (available in 6 different languages). The BRIEF-MPI is also available for free as multi-language app "MPI mobile" for mobile devices and tablet, both for iOS and android systems.

A structured training course was developed including two sessions (one online and one in person) with the aim of effectively training the involved GPs on the study design and the administration of the BRIEF-MPI, to ensure its appropriate use. The training was held by Professional Educators, Geriatricians, and Researchers who developed expertise in the field of CGA and, more specifically, in the administration of the BRIEF-MPI.

The BRIEF-MPI allows to identify the patient's compromised domains and thus to tailor a PPP based on those specific needs and other clinical data such as the adherence to the National Vaccination Prevention Plan (PNPV), collected separately [30]. The domains that will be the target for the PPP were determined based on the BRIEF-MPI impaired domains. The tool gives information on the severity of the impairments which in turn, following a specific given decision-making algorithm, can lead to the prescription of an educational intervention based on specific suggestions, a follow-up visit, or a specialized examination. Demographic data and information about vaccination and NCDs were also collected by the GPs from the patient's clinical records. All the data was gathered in a shared web platform, available to all GPs.

The Personalized Prevention Program (PPP)

The PPP includes a range of preventive indications and interventions aiming at improving: (i) functional, physical, cognitive, and nutritional status; (ii) the management of NCDs and polypharmacy; (iii) adherence to vaccinations, and (iv) the prevention of social isolation. The GPs could provide these suggestions in the form of leaflets containing advice on diet (based on the principles of the Mediterranean diet), physical exercise, the promotion of active and healthy lifestyles and the prevention of cognitive decline, self-management of chronic diseases and polypharmacy, and recommendations on vaccination coverage. Based on the severity of identified conditions, the GPs could request further diagnostic procedures, referral to a specialist and/or personalized treatments. As an example, if the BRIEF-MPI highlighted a suspect of cognitive impairment, the patient was further assessed with the Italian version of the General Practitioner Assessment of Cognition (GPCOG-It) [31]. Based on the result, patients could be referred to a specialist exam or scheduled for a follow-up visit. Similarly, for nutritional status, a condition of malnutrition or obesity could be detected by the administration of a modified version of the Malnutrition Universal Screening Tool (MUST [32]), including a path for obesity treatment.

In case of a detected risk in ADL or IADL domains, the GPs informed the social assistance services and home care, and warn both formal and informal caregivers. The GPs' role in this domain was to intercept the functional needs, alert the specific services available involving social workers, physiotherapists, occupation therapists, and psychologists when appropriated.

In participants at high risk for social isolation and loneliness, the GPs provide general and personalized

suggestions to the individuals, their formal/informal caregivers, and relatives.

Polypharmacy was assessed through the STOPP&START criteria [33] and the intervention was designed accordingly.

The intervention for the prevention of infectious diseases consisted of the GPs recommending to cover the missing vaccinations based on the PNPV.

Table 1 Descriptive statistics, NCDs and multidimensional domains in the intervention group stratified by gender

Parameters	Participants (n = 612)	Males (n = 305)	Females (n= 307)	*p* -value
Age (years, median, IQR)	74 (70–81)	74 (70–81)	75 (70–80)	0.996[a]
Non-communicable Chronic Diseases				
Cardiac (n,%)	232 (37.9%)	143 (46.9%)	89 (29%)	< 0.001*[b]
Hypertension (n,%)	451(73.7%)	230 (75.4%)	221 (72%)	0.336[b]
Vascular (n,%)	140(22.9%)	73 (23.9%)	67 (21.8%)	0.534[b]
Respiratory (n,%)	67(10.9%)	34 (11.1%)	33 (10.7%)	0.875[b]
Eye/Ear/Nose/Throat/Larynx (n,%)	60(9.8%)	40 (13.1%)	20 (6.5%)	0.006*[b]
Gastro-intestinal and hepatic (n,%)	82 (13.4%)	41 (13.4%)	41 (13.4%)	0.975[b]
Renal-Genitourinary (n,%)	161(26.3%)	141 (46.2%)	20 (6.5%)	< 0.001*[b]
Musculoskeletal (n,%)	144(23.5%)	42 (13.8%)	102 (33.2%)	< 0.001*[b]
Neurological (n,%)	45(7.4%)	22 (7.2%)	23 (7.5%)	0.895[b]
Endocrine/metabolic (n,%)	337(55.1%)	156 (51.1%)	181 (59%)	0.052[b]
Psychiatric (n,%)	56(9.2%)	13 (4.3%)	43 (14%)	< 0.001*[b]
BRIEF-MPI domains				
BRIEF-MPI (median, IQR)	0.190 (0.120–0.250)	0.190 (0.120–0.250)	0.190 (0.120–0.250)	0.850[a]
ADL (median, IQR)	3 (3–3)	3 (3–3)	3 (3–3)	0.852[a]
IADL (median, IQR)	3 (3–3)	3 (3–3)	3 (3–3)	0.191[a]
MOB (median, IQR)	3 (3–3)	3 (3–3)	3 (3–3)	0.002*[a]
SPMSQ (median, IQR)	0 (0–0)	0 (0–0)	0 (0–1)	0.012*[a]
MNA-SF (median, IQR)	0 (0–0)	0 (0–1)	0 (0–0)	0.155[a]
Comorbidity (median, IQR)	3 (2–4)	3 (2–4)	3 (2–3)	0.016*[a]
Number of drugs (median, IQR)	4 (3–6)	4 (3–6)	4 (2–6)	0.019*[a]
Co-habitation status (n, %)	Living with family: 498 (81.4%) Institutionalized: 3 (0.5%) Living alone: 111 (18.1%)	Living with family: 263 (86.2%) Institutionalized: 1 (0.3%) Living alone: 41 (13.4%)	Living with family: 235 (76.5%) Institutionalized: 2 (0.7%) Living alone: 70 (22.8%)	0.009*[b]

IQR,inter-quartile range;[a]comparison conducted with Mann-Whitney's U; *, statistically significant comparison, [b],chi-square test for comparison.

Statistical analyses plan

Descriptive statistics of participants were carried out, both in the whole group and stratified by gender. Using the Shapiro-Wilk test, each variable was tested for normal distribution. As all the variables were not normally distributed, continuous data were summarized using medians and interquartile range (IQR). Categorical variables were summarized using frequencies and percentages.

Male and female subgroups were compared using the Mann-Whitney's U test and the Chi-square test was conducted to compare categorical variables. All two-tailed statistical tests were considered statistically significant with a p-value of ≤ 0.05. Jamovi was used for all the statistical analyses.

Results

Data at baseline

Data considered in this study only referred to the 612 people included in the IG. Table 1 reports the descriptive statistics at baseline, the prevalence of NCDs categories and the median scores of the multidimensional domains in the IG overall and stratified by gender. Almost half of the sample was male. The median age of the IG was 74 years, with no statistically significant differences between males (M) and females (F). The most common chronic disease in the sample was hypertension (73.7%) followed by endocrine and metabolic conditions (55.1%). Specifically, differences in the distribution of NCDs between genders highlighted that males were statistically more affected by heart (N. M = 143 *versus* F = 89, $p < 0.001$), eye/ear/nose/throat/larynx (N. M = 40 *versus* F = 20, $p = 0.006$) and renal-genitourinary (N. M = 141 *versus* F = 20, $p < 0.001$) diseases. Conversely, females showed higher prevalence of musculoskeletal (N. M = 42 *versus* F = 102, $p < 0.001$) and psychiatric (N. M = 13 *versus* F = 43, $p < 0.001$) diseases. Regarding multidimensional domain, the total BRIEF-MPI value did not show any difference between genders. However, males showed a higher number of comorbidities ($p = 0.016$) and higher polypharmacy ($p = 0.019$) compared to females, while females showed worse mobility ($p = 0.002$) and cognitive status ($p = 0.012$) compared to males. Differences between groups were also observed in co-habitation status, with females more frequently living alone ($p = 0.009$) compared to males.

Assigned interventions following CGA-based assessment and vaccination coverage

The interventions provided to participants in the IG based on the BRIEF-MPI assessment and their vaccination coverage are reported in Table 2. The majority of participants had an overall low risk of multidimensional frailty (BRIEF-MPI class 1 = 88%) while 12% of participants had a moderate or severe risk of multidimensional frailty (BRIEF-MPI class 2 and class 3, respectively).

Table 2 Scores, category of risk, and prevalence and types of assigned interventions for each domain

Parameters	Total score (Median, IQR)	Category of Risk (*n*, %)	Intervention assigned (*n*, %)
BRIEF-MPI	0.190 (0.120–0.250)	Low: 538 (87.9%) Moderate: 66 (10.8%) Severe: 8 (1.3%)	N.A.
ADL	3 (3–3)	Low: 573 (93.6%) Moderate: 24 (3.9%) Severe: 15 (2.5%)	Pamphlet: 39 (6.4%) Formal or informal care: 12 (2%) Domiciliary Care: 18 (2.9%) Specialistic Examination: 2 (0.3%)
IADL	3 (3–3)	Low: 550 (89.9%) Moderate: 25 (4.1%) Severe: 37 (6.0%)	Pamphlet: 62 (10.1%) Formal or informal care: 32 (5.2%) Domiciliary Care: 19 (3.1%) Specialistic Examination: 4 (0.7%)
MOB	3 (3–3)	Low: 593 (97.1%) Moderate: 12 (2.0%) Severe: 6 (1.0%)	Pamphlet: 18 (2.9%) Specialistic Examination: 3 (0.5%)
SPMSQ	0 (0–0)	Low: 583 (95.4%) Moderate: 18 (2.9%) Severe: 10 (1.6%) Score 0: 478 (78.2%) Score 1: 105 (17.2%) Score 2: 18 (2.9%) Score 3: 10 (1.6%)	Pamphlet: 133 (21.7%) - 130 subjects evaluated with GPCOG-It (3 dropouts). - Based on GPCOG-It scores, specialistic examination was prescribed to 56 subjects - GPCOG-It between 1 and 4: 36 subjects - GPCOG-It between 5 and 8: 84 subjects - GPCOG-It 9: 10 subjects
MNA-SF	0 (0–0)	Low: 461 (75.3%) Moderate: 125 (20.4%) Severe: 26 (4.2%)	Pamphlet: 152 (24.8%) Prescribed further specialistic examination for severe malnutrition: 8 (1.3%) Prescribed further specialistic examination for class II obesity 28: (4.58%) 29 subjects evaluated as mild risk of malnutrition 26 subjects evaluated as moderate risk of malnutrition 37 subjects evaluated as obesity class I
Comorbidity	3 (2–4)	Low: 4 (0.7%) Moderate: 259 (42.3%) Severe: 349 (57%)	Pamphlet: 359 (58.7%)
Number of drugs	4 (3–6)	Low: 253 (41.3%) Moderate: 240 (39.2%) Severe: 119 (19.4%)	Pamphlet: 359 (58.7%)
Co-habitation status	N.A.	Living with family: 498 (81.4%) Institutionalized: 3 (0.5%) Living alone: 111 (18.1%)	Pamphlet: 113 (18.5%) Activation of care services: 1 (0.2%)
Vaccinations coverage			
Flu (n,%)		404 (66%) Males: 199/305 (65.2%) Females: 205/307 (66.8%)	Vaccination plan pamphlet: 606 (99%)
Pneumococcal (n,%)		161 (26.3%)* Males: 93/305 (30.5%) Females: 68/307 (22.1%)	
COVID-19 (n,%)		337 (55.1%) Males: 170/305 (55.7%) Females: 167/307 (54.4%)	
Herpes-Zoster (n,%)		67(10.9%) Males: 37/305 (12.1%) Females: 30/307 (9.8%)	

IQR, inter-quartile range; *, statistically significant comparison between males and females

When considering single domains, most participants were in the low risk category except for the domains of comorbidity and polypharmacy where majority of the participants were in the moderate or severe class risk. Almost 60% of participants potentially required an intervention to monitor comorbidities and polypharmacy. Notably, when considering cognition and nutritional status, 22% and 25% of participants, respectively, needed further examinations and/or a specific PPP.

In the individuals with cognitive decline who underwent the second-line GPCOG-It assessment, a higher prevalence of impairments in ADL ($p < 0.001$), IADL ($p < 0.001$), mobility (MOB) ($p < 0.001$), and higher multidimensional frailty (BRIEF-MPI) ($p < 0.001$), along with lower social isolation and loneliness ($p = 0.007$) compared to the individuals without cognitive impairment were observed (see Table S2).

Individuals at-risk for malnutrition had greater impairments in IADL ($p = 0.008$), mobility (MOB) ($p = 0.026$), cognition (SPMSQ) ($p = 0.008$), and multidimensional frailty (BRIEF-MPI) ($p < 0.001$) compared to participants not at risk for malnutrition (see Table S3).

Participants at risk for social isolation and loneliness showed significantly lower disability in IADL ($p < 0.001$), without significant differences in cognitive impairment, nutritional status, and polypharmacy, despite greater levels of multidimensional frailty ($p < 0.001$) (see Table S4).

Furthermore, vaccination coverage data showed that 99% of the participants reported at least one missing vaccination according to the National Vaccination Prevention Plan (see Fig. 1, Table 2). No differences were found between females and males regarding vaccination coverage, except for anti-pneumococcal ($p = 0.019$).

Results from the CGA-based BRIEF-MPI are summarized in Fig. 2.

Discussion

The PrimaCare_P3 study enrolled older participants with NCDs referred by their GPs to identify their healthcare needs through the CGA-based BRIEF-MPI, aiming to prevent the worsening of clinical and functional conditions related to acute events. The study found that 88% of participants in the intervention group had a low degree of multidimensional frailty (BRIEF-MPI class 1, low risk), thus potentially preventing them from receiving any intervention before a possible worsening of their health conditions and allowing them to be included in a personalized prevention plan.

These findings align with recommendations from published meta-analyses [8], umbrella reviews [7], institutional position papers [6], and guidelines [18], which support the use of CGA to identify and address the healthcare needs of older adults in primary care to prevent negative outcomes such as hospitalization, institutionalization, and frailty.

The PrimaCare_P3 prevention approach relies exclusively on GPs' CGA-based BRIEF-MPI assessment. Comparing this approach to other multi-professional population-based approaches, for example the WHO's ICOPE Program [34] based on identifying intrinsic capabilities, the PrimaCare_P3 approach takes into account certain aspects of CGA allowing a simple evaluation while maintaining the multidimensional framework, leveraging GPs as the frontline gateway in intercepting patients' needs.

The BRIEF-MPI used in this study is a validated CGA-based multidimensional tool covering eight domains following a multidimensional approach to the older person. The tool resulted as having a 92% agreement with the standard version of the MPI [19], and good reliability in an outpatient setting [20], in a hospital setting [21], and in an emergency settings [22]. From an operational point of view, the BRIEF-MPI requires a short training period

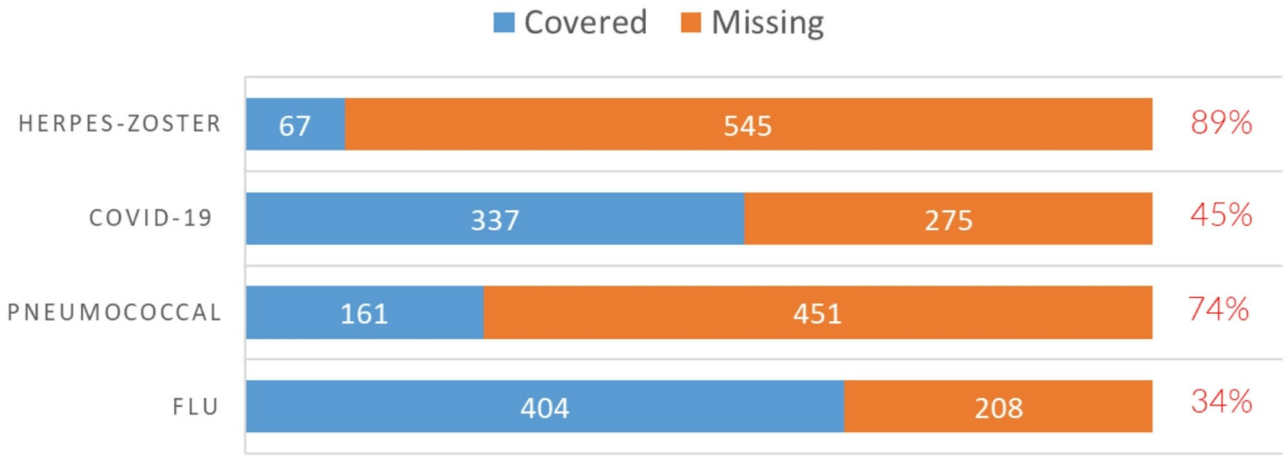

Fig. 1 Baseline vaccination rates in Intervention Group ($n = 612$) participants, according to Italian National Vaccination Prevention Plan

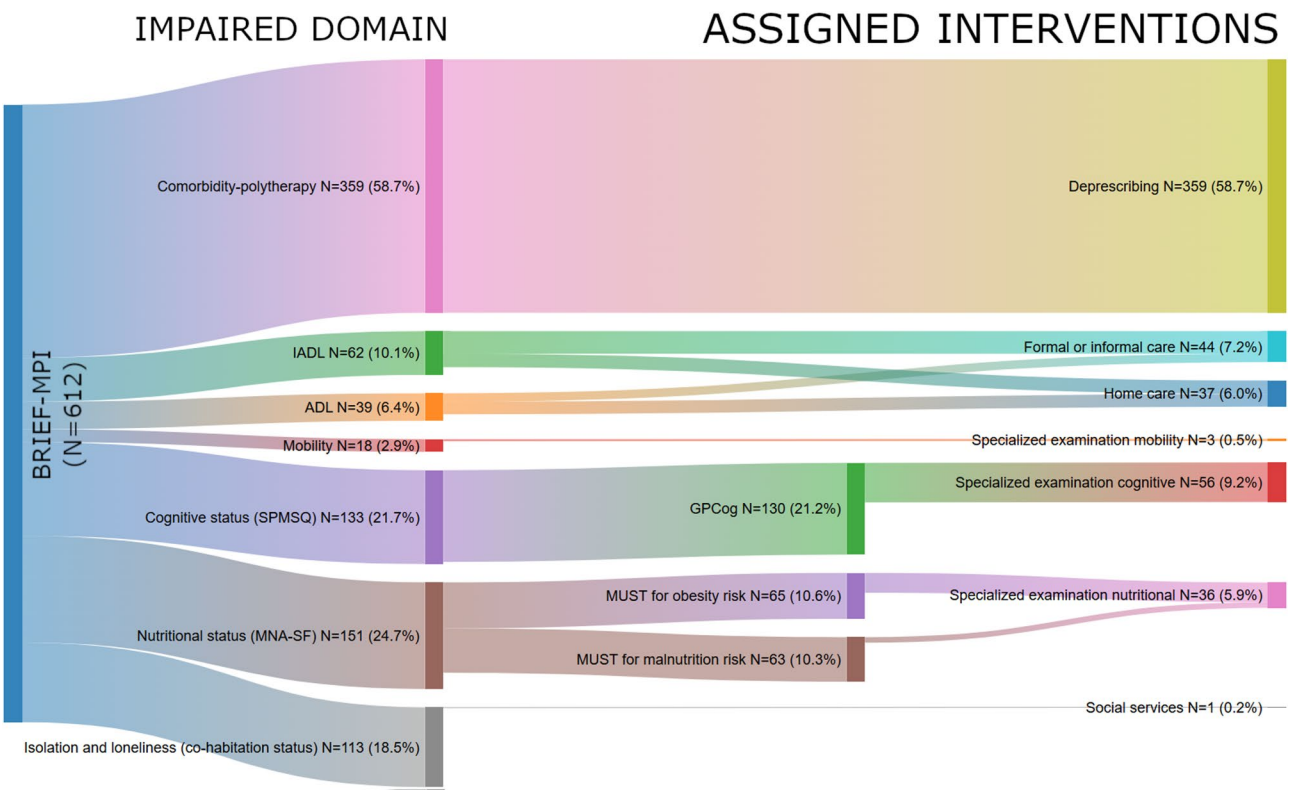

Fig. 2 Prevalences of impaired domains and assigned interventions in Intervention Group participants according to BRIEF-MPI assessment. SPMSQ, Short Portable Mental Status Questionnaire, GPCOG-It, GeneralPractitioner assessment of Cognition – Italian version, MNA-SF, Mini Nutritional Assessment – Short Form, MUST, Malnutrition Universal Screening Tool, IADL, Instrumental Activities of Daily Living – Barthel Scale, ADL, Activities of Daily Living – Barthel Scale

to learn the methodology and a very limited amount of time (usually less than 5 min) for its administration. Moreover, the availability of multi-language user-friendly applications for desktop PC and for mobile devices (i.e., smartphone, tablet), with the automatic calculation of the overall CGA results, facilitates the implementation in clinical practice for healthcare professionals [35].

All investigated domains showed that a high percentage of participants had some level of risk in at least one domain and needed further evaluation and/or some type of intervention by their GPs or the public healthcare system. These data confirm that an assessment through a CGA-based tool, offering a multidimensional perspective on frailty and identifying specific deficits in different domains, could identify some conditions that might otherwise remain unnoticed in a general practice setting. Adopting a proactive medicine approach, as in the PrimaCare_P3 study, has been shown to be useful in initiating a positive care pathway that surpasses the limits of standard usual care [36, 37]. As previously mentioned, this pathway could be initiated by the GPs for their privileged relationship with their patients and subsequently implemented involving public health services and/or other healthcare professionals to carry out an effective PPP according to an interdisciplinary approach. This proactive perspective should also consider the role of gender in specific diseases. Literature reported different probabilities of developing specific disorders in males compared to females, but consistent findings appeared scarce [38]. Some differences in both distribution of NCDs' prevalence and impairments were found in our sample; further studies are needed to explore these gender-specific differences.

More specifically, around 59% of participants ($n = 359$) were considered to be at risk for polypharmacy based on the BRIEF-MPI and 23% of participants ($n = 286$) were reported to habitually take 7 or more medications, and hence to be a candidate to initiate a de-prescribing intervention according to the STOPP&START criteria [33]. This is in line with recent data on the prevalence of drug use reported by the Italian Medicine Agency (AIFA) showing that in 2023, 68% of people aged ≥ 65 years received at least five different prescriptions, with about 29% of older people in Italy taking ≥ 10 medicines per year [39]. These data indicate that polypharmacy in older people referring to the general practice setting should receive more attention and some actions should be taken to reduce the risk of adverse drug reactions (ADR), an avoidable cause of unplanned hospitalizations, healthcare costs and mortality [40, 41]. The need for an early

identification of drug-drug and drug-disease interactions which could be easily managed with appropriate deprescribing is also supported by a recent umbrella review highlighting its positive effect on medication adherence in community-dwelling older people, along with a decrease in potentially inappropriate drug prescriptions in other settings [42].

The second most frequently impaired domain in the study population was nutritional status, with around 25% of participants categorized as having some degree of risk based on the BRIEF-MPI. Malnourished older adults are reported by literature as having a higher mortality rate and a higher risk of developing comorbidities, and as having lower quality of life and less ability to perform activities of daily living [43]. In our sample too, people at-risk for malnutrition reported higher prevalence of cognitive decline, functional and mobility impairments, and an overall higher multidimensional frailty, suggesting the role of an interplay among the different domains in explaining the overall health status of older people. Sixty-three participants (10.3%) were reported as being at risk of malnutrition, and eight of them were referred to a specialist. This type of early assessment, followed by monitoring and appropriate interventions, can improve the nutritional status of community-dwelling older people, as demonstrated by previous studies [43]. Moreover, about 11% of the participants ($n = 65$) were at risk of obesity, and 28 of them were referred to a specialist. The early detection of this condition can prevent its consequences, as reported in literature, such as disability, worsening of chronic conditions [44]. Obesity can also be associated with poorer cognitive performances [45].

Around 22% of the participants reported at least one wrong answer on the cognitive domain of the BRIEF-MPI, thus requiring a further evaluation using GPCOG-It ($N = 130$). These subjects showed greater impairments in functional (ADL and IADL) and mobility (MOB) capacities, along with higher multidimensional frailty (BRIEF-MPI), confirming the importance of a CGA-based multidimensional approach to older people with cognitive impairment. Fifty-six of these participants were referred to a local Center for Cognitive Decline and Dementia (CDCD), while the others were scheduled for a follow-up monitoring of their cognitive status with their GP. The early detection of cognitive impairment can be helpful to identify useful interventions and potentially delay its progression [46].

The global health status can also be affected by loneliness and social isolation [47], which are more common in older people [48]. In our sample, around 18.5% ($n = 113$) of participants were evaluated as being at risk of social isolation and loneliness, which is a phenomenon that GPs are in a privileged position to address in its initial phases [48]. As expected, the subgroup of participants at risk for social isolation and loneliness showed less impairment in the IADL despite being substantially comparable as regards polypharmacy, comorbidities, cognition, and nutrition. However, participants at-risk for social isolation and loneliness displayed greater multidimensional frailty, as assessed by the BRIEF-MPI, compared to participants not at-risk. These data are in agreement with previous longitudinal studies reporting that social isolation and loneliness are potential outcomes of frailty [49].

The possible role of GPs in the prevention of negative outcomes related to NCDs in community-dwelling older population also involves the assessment of potential impairments in ADL, IADL, and mobility. In the IG of the PrimaCare_P3 study, a total of 119 participants (around 20%) were considered as at risk of impaired ADL or IADL. Of these, 90 (around 15%) were referred to a specialist or required the initiation of an intervention. Providing an intervention addressing functional domains to older people in the first stages of frailty was shown to be a cost-effective strategy [50].

The specific role of GPs allows them to form sustained and trust-based relationships with their patients. They thus are in a privileged position to help people achieve positive clinical outcomes and initiate preventive strategies [51], including increasing vaccination rates [52]. Literature highlighted that one of the main reason for this lack in vaccinations in older people are negative and hesitant attitudes towards vaccines [53, 54], thus the role of a trusted physician can facilitate the adherence to PNPV, as previously demonstrated in outpatient settings [55]. Immunization is crucial in older people due to a physiological decrease in antibodies, immuno-senescence, a higher prevalence of some chronic diseases associated with age that might affect immunity, and the severity of vaccine-preventable disease [56, 57]. Despite the undeniable positive effects of vaccination, almost all participants (99%) reported at least one missing vaccination according to the PNPV. The most frequently missing vaccination was herpes zoster (89%), whose complications are more severe in people with chronic conditions, malnutrition and polypharmacy [58]. This high percentage of partial coverage was especially alarming due to the specific characteristics of the older participants included in the IG, which were people having at least one chronic disease Low vaccination rates were also observed for pneumococcus, COVID-19, and flu, suggesting that the role of GPs in the prevention of these infectious diseases could be relevant.

Since a CGA-based multidimensional assessment is far from established in usual practice, a specific training program was provided to GPs through two dedicated learning sessions, one online and one in person, by trained personnel (geriatricians, professional educators, and researchers). A potential limitation of this study can be

due to the large number of patients per GP, that caused some organizational and time-related challenges in their involvement in the PrimaCare_P3 program. Moreover, the potential application of a PPP in general practice is subject to the characteristics of each specific context, such as the presence of an adequate infrastructural network for referring to specialist examinations, and the availability of resources for the required interventions. As an example, GPs can identify missing vaccinations, but other specific and local health services are in charge for the administration of some vaccines, such as the herpes zoster vaccine. This shows how a proactive medical program, while capable of identifying the target areas of intervention, needs to be supported by complementary healthcare public services.

Future research should focus on how to implement CGA-based PPPs into clinical practice and evaluate the cost-effectiveness of the PPP's deployment in primary care settings. Moreover, further investigations are needed to explore the interactions among the different impaired domains to enhance the coordinated and interdisciplinary preventive interventions, as derived from the multidimensional CGA-based approach. Finally, further studies are needed to clarify the pathophysiological and clinical differences in comorbidity patterns between gender groups in old age. In conclusion, the study showed how a multidimensional assessment using a CGA-based such as the BRIEF-MPI could be useful in identifying the needs of older adults that could be addressed through a PPP in a primary care setting.

Supplementary Information

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Supplementary Material 1

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Authors' contributions

AP: conceptualization, methodology, writing– review & editing, supervision, funding acquisition; WM: formal analysis, data curation, writing– original draft, visualization; ES: formal analysis, data curation, writing– original draft, visualization; EL: methodology, writing– review & editing; CC: project administration, supervision; Nicola Veronese: project administration, supervision; PF: investigation, data curation; Carolina Massone: data curation; PP: methodology, investigation; EF: methodology, investigation; PL: methodology, investigation; AM: investigation; GP: investigation; CI: investigation; LB: investigation; MB: supervision; Cesare Massone: supervision, project administration; PLA: supervision, writing– review & editing; Nicola Vanacore: conceptualization, methodology, writing– review & editing, supervision.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Local Ethical Committee (Liguria Region: 15-11-2023, n° 678/2022, registered on clinicaltrials.gov, NCT06224556, 05-01-2024) and conducted following the Declaration of Helsinki. Every human participant has provided their written informed consent to participate in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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