The role of individual characteristics and physical frailty on Health Related Quality of Life: a cross sectional study of Italian community-dwelling older adults

The role of individual characteristics and physical frailty on health related quality of life (HRQOL): A cross sectional study of Italian community-dwelling older adults

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ABSTRACT

The aims of this study were to investigate the relationship between individual characteristics and HRQOL, and to identify which components of physical frailty measured according to Fried's criteria provided a better explanation of HRQOL. Two hundred and fifty-nine older adults (age 74 ± 6 years; 69% were women) living in Piemonte Region were enrolled in this cross-sectional study. Socio-demographic and medical characteristics were captured by self-reported questionnaires. Physical frailty was assessed using the five criteria of Fried: shrinking, weakness, poor endurance and energy, slowness, and low physical activity level. HRQOL was measured with the 36-item Short-Form Health Survey (SF-36), using both the mental (MCS) and the Physical Component Summary (PCS). Among individual characteristics, gender was the best predictor for SF-36, the MCS, and the PCS, with values of R^2 of 12.7%, 12.1%, and 8.8%, respectively. Among the five Fried's criteria, poor endurance and energy had the largest effect on HRQOL with values of ΔR^2 of 13.9% for SF-36, 13.4% for the MCS, and 9.4% for the PCS. Results highlighted the role of the individual characteristics and the single weight of the five components of physical frailty on HRQOL. This knowledge may give new insights about the relations between individual functioning and self-rated health, allowing the development of individualized and more effective preventive interventions for a healthy aging.

1. Introduction

According to Eurostat data (Eurostat, 2012), Italy is one of the "oldest" countries in the world. In Italy, the life expectancy (LE) at birth is now 84 years for women and 79 for men, with a proportion of over 60 years of about 20% in 2011. Unfortunately, the prolonged LE is not accompanied by the increase of healthy life years, defined as disability-free LE, highlighting that we live an increasing number of years in a poor health condition.

Within the context of unhealthy extension of LE, it is necessary to find specific and strong indicators for predicting and preventing negative events of aging. The construct of frailty has been identify as a precursor state of adverse outcomes of aging (e.g., death, hospitalization, dependency in daily activities, institutionalization, falls, fractures, cognitive decline, dementia) (Castell et al., 2013; Chang et al., 2012; Chin, Dekker, Feskens, Schouten, & Kromhout, 1999; Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013; Fried et al., 2001; Jones, Song, & Rockwood, 2004; Rockwood et al., 2005, 1999; Speechley & Tinetti, 1991; Winograd et al., 1991). Frailty is a fearsome condition for older adults, defined as a loss of physiologic reserve and an increased vulnerability to external stresses, deriving from multiple and interactive complex systems (Buchner & Wagner, 1992; Fried et al., 2001; Rockwood, Hogan, & MacKnight, 2000). Frailty is highly prevalent with increasing age (Collard, Boter, Schoevers, & Oude Voshaar, 2012; Shamliyan, Talley, Ramakrishnan, & Kane, 2013). According to the Survey of Health, Aging and Retirement in Europe (Santos-Eggimann, Cuenoud, Spagnoli, & Junod, 2009), 4% of seniors are frail in the age between 50 and 64 years, and 17% in the over 65 years.

Frailty in older adults is closely linked to HRQOL (Chang et al., 2012; Gobbens, Luijkx, & van Assen, 2012; Gobbens & van Assen, 2014; Kanwar et al., 2013; Masel, Graham, Reistetter, Markides, & Ottenbacher, 2009). HRQOL refers to the physical, mental, and social domains of health, seen as distinct domains that can be influenced, in a complex way, by individual's experiences, beliefs,

expectations, and perceptions (Testa & Simonson, 1996). HRQOL provides a patient point of view on effects of interventions, diseases, and processes acting on people. It is a person-centered outcome measure which is more informative than the traditional measures of mortality and morbidity (Idler & Benyamini, 1997; Tsai, Chi, Lee, & Chou, 2007).

The role of socio-demographic characteristics and clinical conditions on HRQOL has been widely investigated in previous studies. A lower income and educational attainment seem to be associated with a reduced HRQOL, as well as the medical conditions could have a negative impact on HRQOL (Gobbens et al., 2012; Lubetkin, Jia, Franks, & Gold, 2005; Zaninotto, Falaschetti, & Sacker, 2009). Zaninotto et al. (2009) reported a significant association between increasing of age and poor HRQOL; unlike, Netuveli and Blane (2008), and Gobbens et al. (2012) did not find it. Wijnhoven, Kriegsman, Snoek, Hesselink, and de Haan (2003) found a worst HRQOL for women compared to men aged between 56 and 75 years and with asthma; whereas, Kirchengast and Haslinger (2008) found a higher level of HRQOL in women aged between 57 and 70 years compared to men of same age, while did not find significant gender differences in the older group (70 years and over). Several pathological conditions, especially chronic diseases, such as hypertension, osteoarthritis, diabetes, depression, asthma, have a negative effect on HRQOL (Brown et al., 2004; Gallegos-Carrillo et al., 2009; Gobbens & van Assen, 2014; Kempen, Ormel, Brilman, & Relyveld, 1997; Lam & Lauder, 2000). Therefore, most of the studies on HRQOL (Hopman et al., 2009; Kempen et al., 1997; Kimura et al., 2010; Lam & Lauder, 2000) were conducted on subjects suffering from diseases with the aim to evaluate the impact of morbidity or the effectiveness of a treatment or intervention. Studies investigated the relation among individual factors and HRQOL reported controversial findings, as mentioned above. In order to clarify this issue, further studies are needed.

Within the literature of frailty, the association between frailty and HRQOL has been widely analysed. Several studies (Bilotta et al., 2010; Chang et al., 2012; Gobbens et al., 2012; Lin et al., 2011; Masel et al., 2009; Puts et al., 2007) found a significant association between frailty status and impairment in the HRQOL in community-dwelling older adults. Precisely, qualitative interviews conducted with 25 older adults in the Netherlands underlined a lower perception of QOL for frail with respect to robust subjects (Puts et al., 2007). Bilotta et al. (2010) reported that physical frailty status measured according to the Study of Osteoporotic Fractures criteria negatively affected five out of seven dimensions of quality of life (QOL) investigated using the Older People's QOL questionnaire in a sample of Italian older adults. Similarly, a better HRQOL for robust compared to frail and pre-frail subjects was found in Chinese (Chang et al., 2012), Mexican American (Masel et al., 2009), and Taiwanese older adults (Lin et al., 2011). In these studies, frailty and HRQOL were evaluated by using the Fried's criteria and the Short Form-36 questionnaire, respectively. Finally, Gobbens et al. (2012) found significant correlations between frailty and QOL, measured using the Tilburg Frailty Indicator (TFI) and the WHOQOL-BREF questionnaire, in a Dutch sample of older adults.

Despite the large number of studies that have addressed the impact of frailty on HRQOL, we still know little about the weight of single components of frailty on HRQOL. Among the five frailty components of Fried et al. (2001), Lin et al. (2011) found that poor endurance and energy had a largest effect on both mental and physical QOL of older adults measured with SF-36, followed by slowness. Whereas, Chang et al. (2012) identified slowness as the major contributing component in the physical scale of SF-36, and poor endurance and energy in the mental scale of QOL. Using the Study of the Osteoporotic Fractures (SOF) criteria for frailty evaluation, the study by Bilotta et al. (2010) reported "reduced energy level" as the first predictor of QOL. Thus, little is known on the impact of single components of frailty on mental and physical domains of HRQOL.

The current study pursued a twofold aim: (i) to investigate the relationship between individual characteristics (socio-demographic and medical aspects) and HRQOL; (ii) to identify which components of physical frailty measured according to Fried's criteria provided a better explanation of HRQOL.

2. Materials and methods

2.1. Study participants and data collection

This research employed a data subset from the Italian Regional project Act on Aging, a longitudinal, intervention research to evaluate the effects of physical and cognitive training in women and men aged 65 years and over. Participants were recruited through the Health Office of Regione Piemonte, general medical practitioners, and local seniors associations. 900 subjects were assessed for eligibility, of which 298 did not meet study's inclusion criteria, 232 declined to participate, and 3 were included in another study. Finally, a total of 367 subjects took part in the Act on Aging project. For this paper, data collected in baseline were used. Excluding missing values (n = 108) from the analysis, 259 subjects were considered. The participants' subset for this study was not statistically different in terms of demographics and cognitive functioning from the whole sample (n = 367) of Act on Aging project.

Participants were included in the study according to the following criteria: (i) aged over 65 years, (ii) ability to walk 500 m without assistance, (iii) a Mini Mental State Examination score greater than 25 (Folstein, Folstein, & McHugh, 1975), (iv) absence of serious health problems (e.g., uncontrolled diabetes or hypertension, myocardial infarction in the previous 1 year, fractures within 6 months), (v) absence of participation in regular moderate or vigorous physical exercise for the last 5 years. All the participants lived in Piemonte Region and did not need for institutional care. People were excluded if they were participating in another study. They provided written informed consent according to Italian law and the ethical code of the American Psychological Association ("Ethical principles of psychologists and code of conduct," 2002). Nobody received incentives for participation. The Ethical Committee of the University of Torino approved the study.

After the screening for inclusion criteria, participants completed a battery of self-report questionnaires concerning demographic characteristics, physical functioning, psychosocial adjustment, QOL, and health condition. A psychologist was always present during the completion of the questionnaires, in order to clarify any doubts. In the same day and after the self-report data collection, a qualified operator graduated in physical education and specialized in adapted physical activity for older adults administered physical tests, always in the same order and individually for each participant. Finally, a biologist with expertise in the field of ergonomics detected anthropometric measures.

2.2. Operationalization of physical frailty

Physical frailty was operationalized here following the five criteria proposed by Fried et al. (2001) in the cycle of frailty. Specifically, the five components are: shrinking, weakness, poor endurance and energy, slowness, and low physical activity level.

Body Mass Index (BMI) less than 21 kg/m^2 was used as an indicator of shrinking (Avila-Funes et al., 2009). Tanita Body Composition Analyzer BF-350 (precision level of 0.1 kg) and an anthropometer (precision level of 0.1 cm, International Standard ISO/TR 7250-2, 2010) were used to measure height and weight.

Hand grip strength was used as indicator of weakness. In this study, the same cut off scores of Cardiovascular Health Study (Fried et al., 2001) was used. A manual dynamometer (Baseline Smedley digital hand dynanometer, model 12-0286) was used to measure grip strength. Three attempts of maximal isometric strength were executed, alternating limbs. The average value of the three measures was computed. The best mean value between right and left limb was used in the analysis.

The following two items of the Center of Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) were used to assess poor endurance and energy: (a) I felt that everything I did was an effort, (b) I could not get going. The statements are referred to the last week. As proposed by Fried et al. (2001), those who answered "a moderate amount of the time (3–4 days)" or "most of the time" to at least one of the questions were categorized as positive for endurance.

Timed Up and Go test (TUG; Podsiadlo & Richardson, 1991) was used to evaluate slowness. Subjects were instructed to rise from a chair, walk three meters, turn around a cone, walk back, and sit down. The TUG was performed one time, in addition to an untimed trial. Reference values of Bohannon (2006) were used to classify subjects as frail for slowness.

The subjects who were not engaged in leisure activities, like hiking, chores (moderately vigorous), gardening, dancing, and cycling at least once a week, were identified as frail for low physical activity (Avila-Funes et al., 2009).

2.3. Individual characteristics

Age (in years), gender, living condition (alone versus live with someone), level of education (in years), and past job (manual versus non-manual work) were self-reported data.

To investigate the use of drugs, the question was "Do you usually use drugs? Yes or No". Only medicines assumed on a regular basis were considered. Vitamins and supplements were not taken into consideration.

2.4. Outcome: health status

To evaluate health status and HRQOL (Mahler & Mackowiak, 1995; Ruta, Abdalla, Garratt, Coutts, & Russell, 1994), SF-36 (McHorney, Ware, & Raczek, 1993; Ware & Sherbourne, 1992) was used. It is composed by 36 questions, subdivided in eight domains: general health, physical functioning, physical role, bodily pain, mental health, emotional role, social functioning, and vitality. The sum of first four domains provides the PCS, as well the sum of the last four MCS. Higher scores are associated with a better health condition. The SF-36 showed to be valid and reliable questionnaire (McHorney et al., 1993; McHorney, Ware, Rogers, Raczek, & Lu, 1992), commonly used in older adults (Beusterien, Steinwald, & Ware, 1996; Horder, Skoog, & Frandin, 2013; Suzuki, Ohyama, Yamada, & Kanamori, 2002; C. Yang, Selassie, Carter, & Tilley, 2012).

2.5. Analysis strategies

All the analyses were conducted with Statistical Package for Social Sciences (SPSS), version 20.0 (Spss Inc., Chicago, IL, USA). Statistical significance level was fixed at $p < 0.05$ for all tests.

Descriptive and frequencies analysis were performed for all the study's variables. *T*-test for unpaired samples and chi-square tests were executed to determine if our participants' subset was not statistically different for individual characteristics and cognitive functioning to the whole sample of Act on Aging project.

Dummies were created for individual characteristics: gender (male = 0, female = 1), living condition (with somebody = 0, alone = 1), past job (manual = 0, non manual = 1), and use of drugs (no = 0, yes = 1). For the level of education, the number of years of schooling was reported (ranged 0–18). BMI was calculated dividing the weight (in kilograms) by height (in meters squared). A one-way analysis of variance (ANOVA) was carried out to determine differences between women and men for individual characteristics and physical functioning.

To investigate the associations between individual characteristics and HRQOL, linear regression analysis for each variable was carried out, using value of explained variance (R square) to evaluate the goodness of the model.

Lastly, to identify which component of cycle of frailty (Fried et al., 2001) better explains HRQOL, hierarchical multiple regression analysis, controlling for age, gender, education, and pharmacotherapy were executed. Five separate models were computed for each frailty indicator and for each outcome (general HRQOL, MCS, and PCS), analysing the changes of R square values to determine the strongest explanatory variable.

3. Results

3.1. Main characteristics of the sample

Table 1 summarizes the main characteristics of participants. Of 259 subjects, the 69% ($N = 178$) were female and the 53% ($N = 137$) lived not alone. The mean age was 74 years (SD = 6; range 65–90). The age between women and men was not statistically different.

The 44% ($N = 114$) of participants had a level of education corresponding to primary school and the 63% ($N = 163$) had performed a manual job before the retirement (e.g., housewife, seamstress, workman, farmer, mason). A high number of participants ($N = 216$, 83%) reported to assume on a regular basis one or more drug. A total of 172 (66%) subjects were engaged in leisure physical activities at least once a week.

Table 1
Main characteristics of participants ($n = 259$).

Variable	*n* (%)
Age, years, *M* (SD)	74 (6)
Gender, *n* (%)	
Male	81 (31)
Female	178 (69)
Living condition, *n* (%)	
Live with someone	137 (53)
Live alone	122 (47)
Level of education, *n* (%)	
Primary school, 5 years	114 (44)
Secondary school, 8 years	81 (31)
High school diploma, 13 years	52 (20)
University degree, 18 years	12 (5)
Past job, *n* (%)	
Manual	164 (63)
Non manual	95 (37)
Pharmacotherapy, *n* (%)	
No	43 (17)
Yes	216 (83)
BMI, kg/m^2, *M* (SD)	28.6 (4.0)
Handgrip, kg, *M* (SD)	
Male	35.9 (5.5)
Female	19.5 (3.2)
CES-D, two items, *M* (SD)	1.7 (1.6)
TUG, seconds, *M* (SD)	9.0 (2.2)
Physically active, *n* (%)	
Yes	172 (66)
No	87 (34)
SF-36, *M* (SD)	86 (17)
MCS	44 (10)
PCS	42 (9)

Note: *M*, mean; SD, standard deviation; BMI computed as weight divided by squared height (kg/m^2); CES-D, two items: (a) I felt that everything I did was an effort, (b) I could not get going; TUG measured in seconds.

Table 2
Relationship between individual characteristics and HRQOL.

Individual characteristics	SF-36			MCS			PCS		
	B	SE	R^2	*B*	SE	R^2	*B*	SE	R^2
Gender	−13.356***	2.187	0.127	−7.566***	1.272	0.121	−5.790***	1.166	0.088
Age (in years)	−0.498**	0.187	0.027	−0.220*	0.109	0.016	−0.277**	0.097	0.031
Living condition	−4.091	2.159	0.014	−2.447*	1.251	0.015	−1.644	1.129	0.008
Education (in years)	1.054***	0.287	0.046	0.500**	0.168	0.033	0.554***	0.150	0.051
Past job	6.003**	2.220	0.028	2.849*	1.293	0.019	3.154**	1.157	0.028
Use of drugs	−8.210**	2.870	0.031	−3.803*	1.674	0.020	−4.407**	1.496	0.033

Note: gender (0 men, 1 women); living condition (0 with somebody, 1 alone); past job (0 manual, 1 non manual); use of drugs (0 no, 1 yes); SE, standard error.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

BMI ranged from 19.8 to 45.0 kg/m^2, with a mean value of 28.6 (SD = 4.0). According to clinical guidelines of National Institutes of Health (US-NIH, 1998), 17% of subjects were classified as normal weight (BMI values: 18.5–24.9 kg/m^2), 54% overweight (BMI values: 25–29.9 kg/m^2), and 29% obese (BMI values: over 30.0 kg/m^2). No gender differences for BMI and BMI category were found.

With respect to physical variables, the mean values for handgrip strength were 19.5 kg (range 6.5–29.9) and 35.9 kg (22.1–59.2) for women and men, respectively. TUG test was performed in an average time of 9.0 s (SD = 2.2; range 5.0–20.3); statistically significant differences were detected between genders ($p = 0.01$), with a better performance for men (mean value of 8.5 s) compared to women (mean value of 9.3 s).

Furthermore, considering the perception of endurance detected with the two items of CES-D scale, the subjects reported a mean score of 1.7 (SD = 1.6), meaning that for "a moderate amount of the time (3–4 days)" they felt as everything is an effort and that they could not get going. The analysis of ANOVA showed significant gender differences ($p < 0.001$) for this variable with a poor endurance and energy for women (mean value of 2.0; range 0–6) with respect to men (mean value of 1.1; range 0–5).

Finally, SF-36 score ranged from 29 to 122, with an average value of 86 (SD = 17). Considering separately the mental and physical component of SF-36, the mean scores obtained were 44 (SD = 10; range 13–64) and 42 (SD = 9; range 16–61), respectively.

3.2. Relationship between individual characteristics and HRQOL

Table 2 shows the results of linear regression analysis on SF-36 and the two component scales of SF-36. Being a man was significantly associated with higher scores for mental and physical components of HRQOL, as well as for general HRQOL. Older age, manual job, few years of school, and use of drugs were associated with lower HRQOL, both for mental and physical HRQOL. Living alone was significantly associated with the mental component of SF-36.

Among individual characteristics, gender had the strongest association with SF-36, MCS, and PCS, with values of explained variance of 12.7%, 12.1%, and 8.8%, respectively. Education was the second one, with values of R^2 of 5.0% for SF-36, 3.0% for the MCS, and 5.0% for the PCS.

3.3. Relationship between components of physical frailty and HRQOL

Table 3 provides the values of explained variance for each component of physical frailty on the general SF-36 and the two summary scales of SF-36, controlling for gender, age, living condition, education, past job, and use of drugs. The ΔR^2 represented the changes in explained variances after adding each single component of physical frailty to individual characteristics. The hierarchical multiple regression analysis showed a significant and negative effect for all the single components of physical frailty, except for shrinking, on general, mental, and physical HRQOL, with β values varying from −0.391 of poor endurance and energy on SF-36 to −0.145 of physical activity level on PCS.

Poor endurance and energy had the largest effect on HRQOL with values of ΔR^2 of 13.9% for SF-36, 13.4% for the MCS, and 9.4% for the PCS. For SF-36, weakness explained 3.2% of the total variance, followed by slowness with 3.0%. Similarly, weakness and slowness explained both 2.6% for the PCS. With respect to the MCS, weakness explained 2.7%, followed by slowness and physical activity with values of ΔR^2 of 2.3%.

Finally, entering all the components of physical frailty into the same model and adding them to the individual characteristics, values of explained variance were 38.9% (ΔR^2 of 19.3%) for SF-36, 33.7% (ΔR^2 of 17.6%) for MCS, and 30.5% (ΔR^2 of 14.5%) for PCS. All the components of physical frailty, with the exception of shrinking, remained significant in the three models.

Table 3
Relationship between components of physical frailty and HRQOL.

Components of physical frailty	SF-36			MCS			PCS		
	β	R^2	ΔR^2 (%)	β	R^2	ΔR^2 (%)	β	R^2	ΔR^2 (%)
Individual characteristics[a]	–	0.196	–	–	0.161	–	–	0.168	–
Shrinking	0.043	0.198	0.2	0.024	0.161	0.0	0.056	0.171	0.3
Weakness	−0.189**	0.228	3.2	−0.173**	0.188	2.7	−0.170**	0.194	2.6
Poor endurance and energy	−0.391***	0.335	13.9	−0.384***	0.295	13.4	−0.322***	0.262	9.4
Slowness	−0.179**	0.226	3.0	−0.158**	0.184	2.3	−0.167**	0.194	2.6
Physical activity	−0.167**	0.222	2.6	−0.159**	0.184	2.3	−0.145*	0.188	2.0

[a] Gender, age, living condition, education, past job, and use of drugs.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

4. Discussion

In this cross-sectional study we achieved a twofold goal. Firstly, we investigated the role of socio-demographic (gender, age, living condition, education attainment, past job) and medical (use of drugs) aspects on HRQOL. Secondly, among the five frailty components of Fried, we identified the major associated factor for general, mental and physical dimensions of HRQOL.

As far as the first point is concerned, in agreement with previous studies (al-Windi, Elmfeldt, Tibblin, & Svardsudd, 1999; Lubetkin et al., 2005), we demonstrated that socio-demographic characteristics influence HRQOL of individuals. As expected, we found that being women, older age, low level of education, manual work, and assumption of drugs were significantly associated with lower scores in SF-36, both in PCS and MCS of SF-36. Conversely, living alone was only associated with lower scores for mental HRQOL. Similar to our results, Lubetkin et al. (2005) examining more than 13,000 American adults found that higher age, being female, lower income and level of education were associated with lower scores of HRQOL. Aghamolaei, Tavafian, and Zare (2010) demonstrated that HRQOL in older adults living in Iran was decreased by aging, being female, illiteracy, and chronic diseases. From the English Longitudinal Study of Aging (Zaninotto et al., 2009) emerged that HRQOL was influenced by several factors, among these level of education, non-employment, and health status.

With respect to age, in concordance with our findings, some studies (Aghamolaei et al., 2010; Zaninotto et al., 2009) reported a significant poorer HRQOL for older compared to younger subjects, highlighting a more rapid decline for the older one (Zaninotto et al., 2009). In agreement with other research (Gallicchio, Hoffman, & Helzlsouer, 2007; Kirchengast & Haslinger, 2008), our results confirmed the strong impact of gender on HRQOL, with lower HRQOL for women compared to men. This finding could be explained in different ways. Women are most likely to suffer from depression (Gonzalez, Haan, & Hinton, 2001; Linden et al., 1998), to have one or more chronic diseases (Phaswana-Mafuya et al., 2013; Wu et al., 2013), and to be involved in care provision (Arber & Ginn, 1995; Vlachantoni, 2010) then men. All these factors, strictly interconnected each other, negatively impacted on HRQOL, as demonstrated by several studies (Barile et al., 2012; Gallegos-Carrillo et al., 2009; X. Yang, Hao, George, & Wang, 2012).

Our study confirmed that socio-demographic and medical characteristics of individuals have an impact on HRQOL. Studies (Blane, Higgs, Hyde, & Wiggins, 2004; Netuveli, Wiggins, Hildon, Montgomery, & Blane, 2006; Wiggins, Higgs, Hyde, & Blane, 2004) demonstrated the role of other factors, among these psychosocial dimension, economic aspects, and health status, on HRQOL of healthy older adults. Although, further research on Italian sample of older adults are needed to investigate more complex relationship among HRQOL and the four categories of factors, summarized as follow by Zaninotto et al. (2009): health, socioeconomic circumstances, psychosocial circumstances, demographic characteristics.

With respect to second aim, among the five frailty criteria of Fried, the major contributing factor on HRQOL was poor endurance and energy. Also considering separately the mental and the PCS of SF-36, the strongest association was with poor endurance and energy. Control for individual characteristics, poor endurance improvement of 13.9%, 13.4%, 9.4% the explanation of general, mental, and physical HRQOL, respectively. Our findings are in agreement with a previous study of Lin et al. (2011) which reported a largest magnitude of the effects of frailty components for poor endurance and energy in both PCS and MCS of SF-36. Similarly, Bilotta et al. (2010) showed that only "reduced energy level", one of the three frailty criteria of the SOF, was independently associated with general QOL, measured by Older People's QOL questionnaire. Differently, Chang et al. (2012) found that slowness was the primary contributing factor in the mental domain and exhaustion in the physical domain of SF-36. Different findings might be explained by the adjusted factors entered in the model. In our study, covariates were limited to socio-demographic characteristics and use of drugs; whereas, Chang et al. (2012) adjusted for a wider number of factors, among these: history of falls, number of comorbidities, and depression. Poor endurance and energy is strictly related to the concept of lack of energy. Cheng, Gurland, and Maurer (2008) called "anergia" the possible lack of energy occurred in older adults and identified it as a key factor for treating impairment in HRQOL. "Anergia" negatively impacted on health services use, mortality rate, and life satisfaction of older adults. Furthermore, it is important to underline that, among the five criteria of Fried, the strongest impact for HRQOL is provided by a self-report based measure, and not by a performance one. In accordance with Sinoff and Ore (1997), self-reported and performance-based measures captured health status differently in older adults, hence the need to integrate information provided by these two measures.

The model as a whole, considering all the frailty factors and adjusting for individual characteristics, explained about 39% of variance. Compared to results obtained by Lin et al. (2011), our model reported a higher explained variance for the MCS (34% versus 13%) and a lower for PCS (30% versus 47%). Therefore, it is reasonable to sustain that different samples and covariates entered in the model might influence the percentages of HRQOL explanation. Gobbens et al. (2012) investigated the impact of background characteristics and physical frailty components measured by the physical domain of the TFI on WHOQOL. Values of explained variance for physical QOL and psychological QOL were 53.6% and 26.4%, respectively. Adding psychological and social components of the TFI, the percentages of explanation were 56.5% for the physical QOL and 46.9% for the psychological QOL. If originally frailty was considered exclusively a medical and physical construct, nowadays many researchers (Gobbens, Luijkx, Wijnen-Sponselee, & Schols, 2010; Rockwood, Stolee, & McDowell, 1996; Rolfson, Majumdar, Tsuyuki, Tahir, & Rockwood, 2006) have recognized its multidimensional nature, reflecting a more integrated and holistic approach for aging studies. Further investigations are needed to understand the weight of single components of different frailty domains on HRQOL and, more in general, on adverse outcomes of aging process.

Our study presented some limitations that should be noted in the interpreting the results. Firstly, the cross-sectional design of the research did not allow to establish the causal relation between physical frailty and HRQOL, and to analyse trends of frailty and HRQOL in a prospective way. Secondly, the adoption of rigorous inclusion criteria (e.g., absence of serious health problems, no participation in regular moderate or vigorous physical exercise for the last 5 years) for participating at the study prevented the generalizability of the results to the entire Italian aged population. Thirdly, more exhaustive information on medical and clinical background of participants (e.g., use of health services, hospitalization, number of falls) may provide a better explanation of HRQOL.

Despite these limitations, our findings have broadened knowledge on the role of individual characteristics and of single frailty criteria on HRQOL in a sample of Italian older adults. In consideration of cross-cultural differences in HRQOL (Buck, Jacoby, Baker, Ley, & Steen, 1999; Molzahn, Kalfoss, Schick Makaroff, & Skevington, 2011), further research in different countries will allow to strengthen the findings of our study. In the same time, there is the need for several longitudinal studies on frailty and HRQOL, in order to understand the trajectories and to establish a causal relation between these closely related concepts. So far, only

one longitudinal study on frailty and HRQOL has been conducted (Gobbens & van Assen, 2014). Gobbens and van Assen (2014) demonstrated the predictive validity of physical, psychological, and social frailty components, assessed using the TFI, on HRQOL in a sample of older adults (aged over 75) living in the Netherlands.

From an applicative point of view, our findings could be useful for preventing or delaying frailty in older adults. By recognizing that poor endurance and energy is the major contributing factor in HRQOL, more specific and targeted preventive interventions that more likely have greater cost-effectiveness may be designed. Kanwar et al. (2013) demonstrated that the prevention of frailty is a successful strategy to improve HRQOL. As showed by several authors, physical exercise (Binder et al., 2002; Chou, Hwang, & Wu, 2012; Gine-Garriga, Roque-Figuls, Coll-Planas, Sitja-Rabert, & Salva, 2013; Oh-Park, Holtzer, Mahoney, Wang, & Verghese, 2011) in frail and pre-frail older adults can provide positive effects on HRQOL. Other typologies (e.g., cognitive, psychological, social, environmental, or multitasking exercise training) of interventions could be implemented.

5. Conclusions

In sum, our study highlighted the role of individual and medical characteristics as well as the single impact of the five frailty Fried's criteria on HRQOL. Our results improved the specific body of literature about mechanisms and relationships between functioning and self-rated health during the aging process. The discovery of relationship is strongly needed in order to identify risks and protective factors for a better aging and to develop new, individualized, and more effective preventive strategies.

Findings reported here are consistent and strongly informative. However, larger studies, with the use of a longitudinal design and with a wider set of individual (e.g., satisfaction for home living environment, negative events in the previous year like death of a loved one or a serious illness) and medical (e.g., history of falls, number and types of comorbidities, history of depression) variables remain needed and suggested.

Conflict of interest statement

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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