Experimental Gerontology 99 (2017) 46–52

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Clinical characteristics and patterns of health deficits of centenarians receiving home care and long-term care services

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ARTICLE INFO

Section Editor: Diana Van Heemst

Keywords:
Aged, 80 and over
Oldest old
Cluster analysis
Geriatrics
Longevity
Nursing home

ABSTRACT

Centenarians (persons aged 100 years and older) are one of the fastest growing cohorts in countries across the world. With the increasing prevalence of centenarians and growing amount of clinical information in large administrative health databases, it is now possible to more fully characterize the health of this unique and heterogeneous population.

This study described patterns of health deficits in the centenarian population receiving care from community-based home care services and long-term care facilities (LTCFs) in Ontario, Canada. All centenarians who received home care and were assessed using the interRAI-Home Care Assessment instrument between 2007 and 2011 (n = 1163) and all centenarians who resided in LTCFs between 2005 and 2011 who were assessed using the interRAI Minimum Data Set (MDS 2.0) (n = 2228) were included in this study. Bivariate analyses described the centenarian population while K-means clustering analyses were utilized to identify relatively homogeneous subgroups within this heterogeneous population.

The 3391 centenarians were aged 100 to 114 (mean age 101.5 years ± 1.9 SD) and the majority were women (84.7%). Commonly reported deficits included cognitive impairment, physical impairment, and bladder problems. Centenarians residing in LTCFs were significantly more likely than centenarians receiving home care services to report cognitive or functional impairment, or to exhibit symptoms of depression. The commonalities and uniqueness of four clusters of centenarians are described.

Although there is great variability, there is also commonality within the centenarian population. Recognizing patterns within the heterogeneity of centenarians is key to providing high-quality person-centered care and to targeting health promotion and intervention strategies.

1. Introduction

Centenarians were the second fastest growing segment of the population in Canada between 2006 and 2011, following closely behind the 60 to 64 years age group (Statistics Canada, 2012). With the rapidly increasing numbers of older adults across many Western countries, health systems and health science researchers are beginning to realize the new challenges created by aging patient populations, including multimorbidity and declines in physical and cognitive function (Murtaugh et al., 2009). While much of the information on centenarians has been derived from census data, less is known about the clinical characteristics and health status of centenarians utilizing health care services.

Research that has focused on variability in the oldest-old is sparse. Studies often pool subjects older than 85 years into a single category, ignoring the vast heterogeneity that exists within this oldest-old subgroup (Fries et al., 2000). The increasing number of centenarians now allows for epidemiological approaches that can be used to develop insights into the health and disease of the oldest-old. Previous research on centenarians has examined the paths centenarians have taken to reach advanced longevity (Evert et al., 2003); however, these paths focus mainly on strategies for survival to advanced age and do not differentiate between levels of functional ability or other clinical characteristics of centenarians once they have reached advanced age (Gondo et al., 2006). Further investigations of heterogeneity among the oldest-old population typically focus on one aspect or domain of functioning (Gerstorf et al., 2006), such as functional status (Gondo et al., 2006), quality of life (Borglin et al., 2006), health and well-being (Thøgersen-

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http://dx.doi.org/10.1016/j.exger.2017.09.010
Received 4 November 2016; Received in revised form 19 July 2017; Accepted 16 September 2017
Available online 21 September 2017
0531-5565/

Ntoumani et al., 2011), cognition (Davey et al., 2013) or social resources (Randall et al., 2010).

The objectives of this study are two-fold: (1) to examine the characteristics of the home care and long-term care centenarian client populations in Ontario, Canada and (2) to explore patterns of health deficits in this population using cluster analysis.

2. Methods

2.1. Study population and data source

This study utilized routinely collected data from the provincial home care system and long-term care facilities (LTCFs) in Ontario, Canada. The Resident Assessment Instrument – Home Care (RAI-HC) tool is mandated for use in Ontario for all long-stay home care clients (those expected to require services for > 60 days) (Morris et al., 1997a; Landi et al., 2000; Hirdes, 2006). This study included home care clients aged 100 years and older assessed using the RAI-HC between 2007 and 2011 (n = 1163). This study also included centenarians who resided in LTCFs between 2005 and 2011 and were assessed using the Minimum Data Set (MDS 2.0) (n = 2228). The MDS 2.0 is collected as part of regular clinical practice and mandated for use by all LTCFs in Ontario, Canada.

The RAI-HC and the MDS 2.0 are part of the interRAI integrated health information system. They share a core set of items and outcome measures enabling comparison of clinical status across care settings (Hirdes et al., 2011). The RAI-HC and MDS 2.0 are validated instruments with demonstrated inter-rater and test-retest reliability (Morris et al., 1997b; Phillips and Morris, 1997; Sgardari et al., 1997; Landi et al., 2000; Jones et al., 2003; Hirdes et al., 2008).

For this study, the most recent assessment after the person turned 100 years old was included. If a centenarian transitioned from community home care to a LTCF then the LTCF assessment was selected for inclusion in the study. Using a common identifier, RAI-HC and MDS 2.0 data were prospectively linked to Ontario hospital administrative databases to examine emergency department utilization (National Ambulatory Care Reporting System, NACRS) and deaths within hospitals (Discharge Abstract Database, DAD). NACRS contains information on presenting complaints, discharge diagnoses and interventions during emergency department visits while the DAD holds demographic, administrative and clinical information on hospital discharges, including deaths (Canadian Institute for Health Information, 2016).

2.2. Outcome measures

Outcome measures contained within both the RAI-HC and MDS 2.0 include the Cognitive Performance Scale (CPS) (Morris et al., 1994); the Activities of Daily Living Hierarchy (ADL-H) (Morris et al., 1999); the Pain Scale (Fries et al., 2001); and the Depression Rating Scale (DRS) (Burrows et al., 2000). The CPS assesses mental status using a scale ranging from 0 (cognitively intact) to 6 (severe cognitive impairment) (Morris et al., 1994; Paquay et al., 2007). A score of 1 or greater indicates presence of cognitive impairment. The CPS has been validated against the Mini-Mental State Examination (Folstein et al., 1975), the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), and the Test for Severe Impairment (Albert and Cohen, 1992) with coefficients ranging between r = 0.69 and r = 0.81 (Jones et al., 2010; Landi et al., 2000; Morris et al., 1994) and has shown high inter-rater reliability (Hartmaier et al., 1995; Gerritsen et al., 2004). The ADL-H incorporates information on personal hygiene, toilet transfer, locomotion, and eating status to measure physical function using a scale ranging from 0 (independent) to 6 (totally dependent) (Morris et al., 1999). The ADL-H reliably assesses change in ADL impairment over time (Morris et al., 1999) and has shown acceptable validation against the Barthel Index (r = 0.74) (Landi et al., 2000). A score of 1 or greater indicates presence of functional impairment. The Pain Scale is scored using two items ranging from 0 (no pain) to 4 (excruciating pain) (Fries et al., 2001). The Pain Scale has been validated against the Visual Analogue Scale showing strong inter-rater reliability ($\kappa = 0.71$) and has been used across care settings (Fries et al., 2001; Maxwell et al., 2008; Zwakhalen et al., 2009; Zyczkowska et al., 2007). A score of 1 or greater indicates presence of pain. The DRS indicates risk for depression calculated using seven mood and behaviour items each scored as 0 (not exhibited in last 30 days), 1 (exhibited up to five days a week), or 2 (exhibited daily or almost daily) to a maximum score of 14. A score of ≥ 3 is an indicator of depression symptoms. The DRS has been validated against the Hamilton Depression Rating Scale (Hamilton, 1960) and the Cornell Scale for Depression in Dementia (Alexopoulus et al., 1988) with corresponding coefficients of r = 0.69 and r = 0.70 respectively (Burrows et al., 2000).

Selected health conditions from the RAI-HC and MDS 2.0 were grouped into the following categories: heart/circulation problems (1 or more of the following: cardiovascular accident, congestive heart failure, hypertension, peripheral vascular disease), musculoskeletal problems (1 or more of the following: arthritis, hip fracture, osteoporosis), neurological conditions (1 or more of the following: Parkinsonism, multiple sclerosis, dementia (Alzheimer's disease or other dementia)), and respiratory conditions (1 or more of the following: COPD, emphysema, asthma).

Health deficits were measured using a count of the following diagnoses, impairments, or problems: cognitive impairment (CPS > 1), impaired physical function (ADL-H > 1), presence of depressive symptoms (DRS 3 +), pain (Pain Scale 1–4), unintended weight loss, unstable health, impaired hearing, impaired vision, bladder problem (incontinence), diagnosis of cancer, diagnosis of diabetes, heart/circulation condition (cardiovascular accident, congestive heart failure, hypertension, or peripheral vascular disease), musculoskeletal condition (arthritis, hip fracture, osteoporosis), neurological condition (Parkinsonism, multiple sclerosis, dementia (Alzheimer's disease or other dementia), or respiratory condition (COPD, emphysema, or asthma).

2.3. Analysis

Cluster analysis was conducted to identify patterns of health deficits in a population of centenarian health care users. Data from both home care clients and LTCF residents were pooled and the K-means clustering algorithm was utilized to segment the sample into relatively homogeneous subgroups. The K-means clustering approach is a data partition method used in segmentation models where the goal is to identify subgroups with similar characteristics (MacQueen, 1967). This algorithm is commonly used within the data mining and machine learning community, and has been shown to be a useful tool to identify patterns of clinical features among geriatric home care clients (Armstrong et al., 2012). As a large number of variables were available for inclusion in the current study, a variable selection technique (PROC VARCLUS) in SAS 9.2 (SAS Institute, Cary, NC) was used to reduce redundant variables prior to cluster analyses. Based on results of the variable selection procedure, fifteen variables were selected for inclusion in the K-means analysis (see complete list in Table 2). Items and scales were dichotomized to indicate independence (0) vs. dependence (1) or absence (0) vs. presence (1) of a health condition.

The K-means approach requires that the user specify the number of clusters, represented by K. Due to the exploratory nature of this work and lack of previous knowledge of K, we used an iterative process where we examined a range of potential clustering solutions (K ranging from 2 to 20). Statistical information, including the cubic clustering criterion, the pseudo F statistic, and the squared multiple correlation was used to inform the selection of K. Analyses were performed using SAS Version 9.2 (SAS Institute Inc., Cary, North Carolina), with an alpha level of $p < 0.05$ for all statistical tests.