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Social Determinants and Health Behaviours among Older Adults Experiencing Multimorbidity Using the Canadian Longitudinal Study on Aging

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Article

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Résumé

Cette étude examine les associations entre les facteurs comportementaux liés au mode de vie et les évaluations portant sur le "vieillissement en bonne santé" chez les personnes âgées présentant une multimorbidité. Le cadre analytique est basé sur un modèle des déterminants sociaux et des comportements liés à la santé (MDSCLS). Les données de base de l'Étude longitudinale canadienne sur le vieillissement provenant de 12 272 Canadiens âgés de 65 ans ou plus ayant déclaré au moins deux des 27 conditions chroniques ont été utilisées. Des analyses supplémentaires ont été effectuées sur trois grappes de multimorbidité : cardiovasculaire-métabolique, musculosquelettique, santé mentale. Lorsque la multimorbidité et les trois grappes sont considérées, la régression logistique hiérarchique permet de constater que le vieillissement en bonne santé est associé au fait de ne pas fumer (sauf pour la grappe de la santé mentale), à l'obésité (sauf pour la grappe cardiovasculaire-métabolique), à un meilleur sommeil et à un meilleur appétit, mais non à l'inactivité. Plusieurs covariables sociodémographiques, environnementales et liées à la maladie ont été incluses. Les résultats sont examinés selon l'optique du MDSCLS, en association avec le concept de résilience, afin de déterminer comment les comportements modifiables liés à la santé peuvent devenir des ressources pour l'atténuation des adversités dues à la multimorbidité. Cette étude a des implications pour le vieillissement en bonne santé des personnes avec multimorbidité, particulièrement en contexte de pandémie de la COVID-19.

Abstract

This study examines associations between lifestyle behavioural factors and appraisals of "healthy aging" among older adults experiencing multimorbidity. A Social Determinants and Health Behaviour Model (SDHBM) is used to frame the analyses. Using baseline data from the Canadian Longitudinal Study on Aging (CLSA), we studied 12,272 Canadians 65 years of age or older who reported 2 or more of 27 chronic conditions. Additional analyses were conducted using three multimorbidity clusters: cardiovascular/metabolic, musculoskeletal, and mental health. Using hierarchical logistic regression, it was found that, for multmorbidity and the three illness clusters, healthy aging is consistently associated with not smoking (except for the mental health cluster), an absence of obesity (except for the cardiovascular and metabolic cluster), better sleep, and a better appetite. It is not associated with inactivity. Several socio-demographic, environmental, and illness covariates were also supported. The findings are examined using the SDHBM coupled with a resilience lens in order to elucidate how modifiable health behaviours can act as resources to mitigate multimorbidity adversities. This has implications for healthy aging for persons with multimorbidity, especially during the COVID-19 pandemic.

Introduction

Over the last few decades, researchers have increasingly investigated the ways in which individuals respond to illness-related adversities to maintain or regain a sense of wellness in their lives, especially over the latter stages of the life course (Sells et al., 2009; Windle, Woods, & Markland, 2010). A prevalent health condition experienced among people of advanced age is multimorbidity, which is the co-occurrence of two or more chronic illnesses (Salive, 2013). It has been estimated that at least two thirds of older adults in many developed countries, including Canada, the United States, and Australia have been diagnosed with two or more chronic conditions (Islam et al., 2014; Wister et al., 2016), and these rates rise among the very old. For example, based on United States clinical data, Salive (2013) reports prevalence rates of multimorbidity in the United States of 62 per cent among persons 65–74 years of age, 75.7 per cent among persons 75–84 years

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of age, and 81.5 per cent among persons ≥ 85 years of age. Multimorbidity is receiving increasing attention as an important health condition, given that it is associated with several deleterious outcomes, including loses of functional ability, social roles, and quality of life (Galenkamp, Braam, Huisman, & Deeg, 2011), as well increased utilization of health care resources and associated costs (Agborsangaya, Lau, Lahtinen, Cooke, & Johnson, 2013).

Multimorbidity, and the presence of chronic illnesses generally, are typically conceptualized as pathogenic processes with significant adversity often tied to a disablement process defined as difficulty accomplishing desired activities as a result of health or physical challenges (Verbrugge & Jette, 1994). Yet, even in the face of objective illness, most older adults report higher than expected levels of well-being, successful aging, life satisfaction, and perceived health (Wister, Levasseur, Griffiths, & Fyffe, 2015), what has been termed the "well-being paradox" (Netuveli & Blane, 2008). One interpretation of this apparent contradiction is that some individuals can utilize attitudes, beliefs, resources, and behaviours in order to adapt or cope with the deleterious consequences of multimorbidity, resulting in a sense of healthy aging. Furthermore, in some instances, persons managing co-occurring chronic illnesses may be able to "bounce back" from illness-related adversities, which is called "resilience" (Resnick et al., 2019; Windle, 2011). One area of interest is the extent to which health behaviours play a role in shaping perceptions of healthy aging among those with multimorbidity, given that a positive view of aging can be instrumental in chronic illness management (Antonovsky, 1996; Ong, Bergeman, Bisconti, & Wallace, 2006; Wister, Kendig, Mitchell, Fyffe, & Loh, 2016). Since health behaviours are mutable and have the potential to improve population health and reduce strains on health care systems, it is not surprising that researchers are interested in their role in adaptations to multimorbidity (Short & Mollborn, 2015).

Thus, when older people with multiple chronic conditions report high levels of healthy aging, this may be indicative of resilience in that they perceive themselves to be coping with adversity (Pruchno & Carr, 2017). Perceptions of how well one is aging may be a potentially useful approach to investigating resilience. While as there is a lack of agreement pertaining to resilience measures and operationalization (Cosco et al., 2017; Cosco, Kok, Wister, & Howse, 2019), global measures, such as appraisals of healthy aging, successful aging, happiness, and well-being, have the potential to capture the inherent complexity of underlying concepts such as resilience (Galenkamp et al., 2011). Furthermore, while resilience models have been applied to numerous forms of adversity in older persons including chronic illness and multimorbidity (Rybarczyk, Emery, Guequierre, Shamaskin, & Behel, 2012; Sells et al., 2009; Trivedi, Bosworth, & Jackson, 2011; Wister & Cosco, 2021; Wister, Kendig, et al., 2016), there is a need for further research pertaining to the predictors, processes, and mechanisms associated with resilience, including the role of health behaviours in later life.

Therefore, this article addresses two primary research questions. (1) What are the modifiable behavioural lifestyle factors that are associated with healthy aging, adjusting for key covariates? and (2) Do these patterns differ across multimorbidity types and clusters? This has tremendous import, because it has been estimated that health behaviours account for approximately 40 per cent of health care costs in the United States (McGinnis, Williams-Russo, & Knickman, 2002), and furthermore, health promotion interventions need to be tailored and targeted to maximize their potential (Kendig, Browning, Thomas, & Wells, 2014; Rootman, Pederson, Frohlich, & Dupéré, 2012).

Social Determinants and Health Behaviours for Healthy Aging

A social determinant of health model (Raphael, 2016) is incorporated in order to connect healthy lifestyle behaviours and perceptions of healthy aging and to frame the analyses. This approach views health as a social construct that traverses holistic, multi-level, and cumulative process over the life course. Social determinants of health include the nexus of a number of factors often deemed to increase inequality from policy (upstream) down to the individual (downstream) levels (Braverman, Egerter, & Williams, 2011; Short & Mollborn, 2015). This approach began by emphasizing the social milieu of health: social contexts, such as socio-economic status; living and working conditions; the physical environment, and social support from family, friends, and the community Prus 2011; Raphael, 2016; Rootman et al., 2012). It has been integrated within federal public policy approaches in Canada, such as the Population Health Model (Hamilton & Bhatti, 1996). More recently, there has been an application of the original model to health behaviours, what we call the Social Determinants of and Health Behaviour Conceptual Framework (Short & Mollborn, 2015). It considers both health and healthy lifestyle behaviours as embedded in structure and agency, as well as with genetic and physiological determinants of health (Short & Mollborn, 2015). As such, they embody not only structural determinants of health (socio-economic opportunities, social support systems, living environments) but also those connected to the role of social-psychological determinants, such as perceptions of healthy aging (Kendig et al., 2014). The latter builds on Antonovsky's (1996) salutogenic processes connected to quality of life and well-being, which are distinct from the pathogenic clinical causes and trajectories of psychopathology and disease.

Furthermore, the literature on resilience and aging has investigated a range of areas within which individuals harness resources to foster positive adaptation to illness, including psychological, emotional, spiritual, physical/functional, economic, cultural, and social or ecological domains (Cosco, Wister, Brayne, & Howse, 2018; Linkov & Kott, 2019; Ong et al., 2006; 2010; Silverman, Molton, Alschuler, Ehde, & Jensen, 2015; Wiles, Wild, Kerse, & Allen, 2012; Wister, Rosenkrantz, Shashank, Walker, & Schuurman, 2020). Applied to multimorbidity, some individuals may (or may not) possess important resilience attributes, such as healthy lifestyle routines, social support resources, economic resources, and social-psychological strengths that may generate positive appraisals of healthy aging (Kendig et al., 2014; Rybarczyk et al., 2012; Sells et al., 2009; Trivedi et al., 2011; Windle, 2012). We consider positive perceptions of healthy aging among persons with multimorbidity as an indicator of resilience, given that individuals with multimorbidity typically face significant adversities, and appraisals of healthy aging capture elements of successful aging, positive adaptation, comparisons with peers, and temporal dynamics of aging processes, as these appraisals denote a life course element. This approach parallels research that has used self-rated health as a global indicator of complex concepts such as health-related quality of life, and as a predictor of morbidity and mortality (Galenkamp et al., 2011; Idler & Cartwright, 2018).

A core phase of the resilience process is the accessing and activation of internal and external resources from a strength-based lens, including health behavours, social support, and socio-economic status (Richardson, 2002; Sells et al., 2009; Resnick et al., 2019). Although appraisals of healthy aging do not constitute a formal resilience measure (Cosco et al., 2019), they can be a crude

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indicator among individuals facing adversity. This article focuses on health behaviours, because they are deemed to be central components of healthy aging among persons faced with the physical, social, and psychological adversities of multimorbidity (Kendig et al., 2014; Wister, Cosco, Mitchell, & Fyffe, 2020).

Behavioural/Lifestyle Predictors of Healthy Aging

Health behaviours have been established as primary predictors of well-being in old age, morbidity, and survival. Research has begun to link several lifestyle factors to multimorbidity, including smoking, physical activity, and obesity/nutrition (Agborsangaya, Ngwakongnwi, Lahtinen, Cooke, & Johnson, 2013; Autenrieth et al., 2013; Canizares, Hogg-Johnson, Gignac, Glazier, & Badley, 2017; Wister, 2019). For example, Agborsangaya, Ngwakongnwi, et al. (2013) found that obesity increased the number and clustering of chronic illnesses, and Canizares et al. (2017) identified successive cohort increases (being born between 1925 and 1974) in multimorbidity between 1994 and 2010 that were inflated by being obese, a smoker, and sedentary. The positive effects of physical activity as well as the quality and quantity of sleep have also been identified as promoting coping and recovery from multimorbidity (Ezeamama et al., 2016; Wister, 2005). These health behaviours are considered to be health deficits or credits that affect the ability of individuals to manage and respond to both objective (e.g., symptoms) and subjective (e.g., low self-efficacy) illness-related stressors, harness social connections and support, and enhance well-being (Jones et al., 2018; Kendig et al., 2014; Pruchno & Wilson-Genderson, 2012; Wister, Cosco, et al., 2020). Thus, we hypothesize that the above health behaviours will be associated (either negatively or positively) with healthy aging in older adults even after accounting for socio-demographic, socio-economic, and illness-related covariates.

Additional covariates are potential predictors of healthy aging based on known epidemiological influences on multimorbidity. These can be separated into modifiable (education, income level, living/housing and urban/rural environment, and social support), and non-modifiable factors (genetics, age, foreign born status) (Canizares et al., 2017; Sells et al., 2009; Ungar, 2011; Windle, 2012). The type and severity of illnesses contributing to multimorbidity, and perceptions of pain, functional ability, and comorbidity, represent illness contextual factors that should also be included in an analysis of appraisals of healthy aging and resilience (Ong, Zautra, & Reid, 2015; Peters et al., 2019; Sells et al., 2009). For example, greater perceived pain will act as a barrier to good health, as it can be debilitating to an individual's ability to function (Trivedi et al., 2011). In addition, functional status influences the ability to complete activities of daily living.

Methods

Design and Sample

The Canadian Longitudinal Study on Aging (CLSA) data set was utilized in this research. This 20-year panel study of persons 45–85 years of age was initiated in 2010, funded primarily by the Canadian Institutes for Health Research (CIHR), Canada's federal granting agency for health research. A large set of multidisciplinary data was collected at baseline between 2012 and 2015 (see Raina et al., 2009 and Raina et al., 2019 for full sampling details) for the 51,338 participants in the CLSA.

In order to obtain the sample of participants for this research, two CLSA data sets were merged. This included the comprehensive CLSA data set and the tracking CLSA data set. The comprehensive data set consisted of 30,097 participants who were randomly selected within age/sex strata from within 25 km of dense population data sites, or within 50 km of data collection sites in areas with a lower population density. There were 11 data collection sites located in seven provinces across the country. The tracking data set included a cohort of 20,341 participants who were interviewed with a computer-assisted telephone interviewing device. These tracking participants were randomly selected within age/sex strata from areas outside of data collection site zones throughout the rest of Canada. Sample weights were used to correct for sampling error by age, gender, and geographic location (Kirkland et al., 2015).

Given our interest in multimorbidity among older adults, our study included only persons 65 years of age or older who reported having two or more chronic conditions. The sample included self-reports of 2 or more of 27 physical chronic conditions in the CLSA. The chronic illnesses used in this study included Alzheimer's disease, back problems, bowel incontinence, cancer, cataracts, diabetes, epilepsy, glaucoma, heart attack, heart disease, high blood pressure, irritable bowel syndrome, kidney disease, Parkinson's disease, peripheral vascular disease, lung disease, macular degeneration, multiple sclerosis, osteoarthritis, osteoporosis, migraine headaches, rheumatoid arthritis, stroke, thyroid problems, transient ischemic attack, ulcer, and urinary incontinence. Because there is a lack of uniformity in adding mental health variables, such as anxiety, as a chronic illness rather than as an outcome of physical illness (Schafer et al., 2010; Sells et al., 2009), we conducted a separate parallel analysis of a mental health multimorbidity cluster (described subsequently).

For this study we employed a subset of the participants who were 65 years of age and older and were diagnosed with at least two multimorbid chronic conditions ($n = 17{,}148$). We used weighted frequencies for the descriptive analyses, and unweighted frequencies for the multivariate analyses, which when weighted equaled 12,272 (because of oversampling of older age groups) participants.

Measures

The validity and reliability of all relevant measures in the CLSA questionnaires, as well as the references, can be found on the data portal of the CLSA Web site (wwww.clsa-elcv.ca).

Dependent Variable Development

The primary dependent variable is derived from an ordinal scale based on the question: "In terms of your own healthy aging, would you say it is excellent, very good, good, fair, or poor?" The original Likert ordinal measure ranged from "excellent", "very good", "good", "fair", to "poor". This healthy aging variable was dichotomized into: "excellent", "very good", and "good" (1) and "fair", and "poor" (0), with 87.3 per cent in the positive appraisal group (see Table 1). We contend that older adults with multimorbidity who report higher levels of healthy aging show higher levels of coping and resilience.

Socio-Demographic Variables

As shown in Table 1, the following socio-demographic independent variables were included: age, gender, educational level, total household income, marital status, and immigration status. Age was an interval variable and ranged from 65 to 85. Sex was a dichotomous variable coded with females as the reference category. The education level variable assessed the highest degree, certificate, or

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diploma that the participant had obtained. This ordinal variable was measured with the following dummy coded categories: "no post-secondary degree, certificate, or diploma" (reference) "trade certificate or diploma", "bachelor's degree", "university degree or certificate above bachelor's degree". Total household income was also dummy coded using the available categories in the data set as possible responses: "less than $20,000" (reference), "$20,000–$49,999", "$50,000–$99,999", "$100,000–$149,999", "$150,000 or above", and "missing." Marital status was dichotomized as "single, never married or never lived with a partner", "widowed", "divorced", "separated" (reference), and "married/living with a partner in a common-law relationship". Immigration status was dichotomized into "born in Canada" and "immigrant".

Social and Environmental Variables

Number of friends, number of relatives, housing problems, and urban/rural status were included as social-environmental covariates. The variable measuring number of friends assessed how many people a respondent considered to be close friends. Total scores for this continuous variable ranged from 0 to 90. Number of relatives was a count of how many other living family members reported in the participant's network and had a range of 0 to 100. The housing problems variable was computed based on an additive scale based on a series of questions that asked participants if they had answered 'no' to the following: condensation; problems with electrical wiring, plumbing, or heating; infestations; leaking; and noise, as well as answering 'yes' to maintenance and repairs. The urban/rural status variable was dichotomized into "rural" and "urban."

Behavioural Lifestyle Variables

Behavioural lifestyle factors/indicators included body mass index (BMI), physical inactivity, smoking, restless sleep, skipped meals and poor appetite. These were derived from multimorbidity and healthy aging research studies related to lifestyle factors (Agborsangaya, Ngwakongnwi, et al., 2013; Autenrieth et al., 2013; Canizares et al., 2017; Kendig et al., 2014; Wister, Cosco, et al., 2020). BMI was dummy coded into categories using normal (18.5–24.9) as the reference group, underweight ($\leq$ 18.49), overweight (25–29.9), and obese ($\geq$ 30). The physical inactivity measure was based on the Physical Activity Scale for the Elderly (PASE) (Smith, 1991). This variable asked how many hours per day a respondent engaged in sitting activities, which has been associated with poor health outcomes (Guralnik et al., 1994). This variable used the response set: sitting "less than 1 hour", "1 hour but less than 2 hours", "2 hours but less than 4 hours", and "4 hours or more". The smoking variable was used based on responses to the question of whether or not a respondent had smoked cigarettes in the past 30 days. Restless sleep was a single item measure taken from the 10-item Center for Epidemiological Studies Depression Scale that assessed how frequently a respondent experienced restless sleep per week. This variable had the possible responses: "all of the time (5–7 days)", "occasionally (3–4 days)", "some of the time (1–2 days)", or "rarely or never (< 1 day)". Lastly, two eating variables were also included. The first was a variable measuring the degree to which a participant generally described his or her appetite. This variable included the responses: "poor", "fair", "good", and "very good". The second variable was based on an ordinal response to a question as to the frequency of skipping meals. This was dichotomized into "rarely or never" and "sometimes to always".

Health Context Variables

Scales measuring pain, the Older Americans Resources and Services (OARS) physical activities of daily living scale, and multimorbidity scales were incorporated in order to capture the illness context. Pain was measured using an ordinal variable based on responses to a question pertaining to the usual intensity of pain or discomfort and included "none", "mild", "moderate", and "severe". The OARS physical activities of daily living scale measured the degree to which a respondent experienced restriction-free physical mobility. This variable ranged in scores from 2 to 14 with higher scores representing better mobility. Multimorbidity was measured based on a scale of 27 chronic conditions including: Alzheimer's disease, back problems, bowel incontinence, cancer, cataracts, diabetes, epilepsy, glaucoma, heart attack, heart disease, high blood pressure, irritable bowel syndrome, kidney disease, Parkinson's disease, peripheral vascular disease, lung disease, macular degeneration, multiple sclerosis, osteoarthritis, osteoporosis, migraine headaches, rheumatoid arthritis, stroke, thyroid problems, transient ischemic attack, ulcer, and urinary incontinence. This base multimorbidity 27 additive scale was included as the final health factor, because individuals can have more than two chronic illnesses. This variable was called "co-morbidity" for the specific cluster conditions because it included concurrent chronic conditions beyond those included in each cluster.

The independent variable with a significant amount of missing data was total household income. The missing data were added as a separate category and were dummy coded. The small amount (< 5%) of missing data for the remaining variables was recoded to the respective means (continuous) or modes (categorical). Missing data were also removed and analyses repeated with no changes to the substantive findings.

Data Analysis

After validating assumptions, binary logistic regression modeling was employed using SPSS 24 in order to determine the associations between the dichotomized healthy aging variable and four sequentially ordered blocks of predictors: (1) socio-demographic, (2) social/environmental, (3) behavioural lifestyle, and (4) illness context. Logistic regression is a technique that has been specifically developed to examine dichotomous associations, especially those that are positively skewed such as the one used in this research. Model odds ratios (ORs), ORs, and significance levels are reported. In addition, logistic regression analyses of healthy aging were conducted on individuals with multimorbidity (two or more conditions), as well as the three multimorbidity clusters. Logistic regression removes the weighting when generating models.

Multimorbidity Cluster Subsample Rationale

Additional analyses were conducted on three multimorbidity clusters. Although the "two or more illnesses" definition has been widely used in multimorbidity studies, some researchers contend that this approach does not account for the fact that illnesses vary in their influence on aging, and furthermore, that some illnesses more than others have been found to occur concurrently (Prados-Torres et al., 2012). Two of the most prevalent statistical methods include latent class analysis (see Whitson et al., 2016) and tetrachoric factor analysis (see Schafer et al., 2010). Although there is a lack of consensus pertaining to illness clusters to date, we identify, a priori, three separate clusters for subsequent analyses that have a high

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Table 1. Descriptive data for dependent and independent variables for Canadians 65 years of age or older with two or more chronic conditions, CLSA weighted (n = 12,272)

Dependent Variable			Frequency (%)
Perceived healthy aging	Poor / Fair		1,135 (9.2)
	Good / Very good / Excellent		11,137 (90.8)
Continuous Independent Variables	**Range**	**Mean**	**Standard Deviation**
Age	65 to 89	73.10	5.70
Number of friends	0 to 90	5.81	7.48
Number of relatives	0 to 100	31.34	26.90
OARS ADL Scale	2 to 14	13.56	0.91
Multimorbidity 27 Scale	2 to 16	4.07	1.99
Independent Variables			**Frequency (%)**
Gender	Female		6,926 (56.4)
	Male		5,346 (43.6)
Education	No post-secondary degree, certificate, or diploma		4,090 (33.3)
	Trade certificate or diploma		4,014 (32.7)
	Bachelor's degree		2,118 (17.3)
	University degree or certificate above bachelor's		2,050 (16.7)
Household income	<$20,000 per year		874 (7.1)
	$20,000-$49,999		4,381 (35.7)
	$50,000-$99,999		4,171 (34.0)
	$100,000-$149,999		1,196 (9.7)
	≥$150,000		555 (4.5)
	Missing		1,096 (8.9)
Marital status	Not married		4,307 (35.1)
	Married or common law		7,965 (64.9)
Immigration status	Born in Canada		9,979 (81.3)
	Immigrant		2,293 (18.7)
Province	Ontario		2,743 (22.3)
	Alberta		1,000 (8.2)
	British Columbia		2,039 (16.6)
	Manitoba		1,137 (9.3)
	New Brunswick		363 (3.0)
	Newfoundland and Labrador		786 (6.4)
	Nova Scotia		1,104 (9.0)
	Prince Edward Island		306 (2.5)
	Quebec		2,413 (19.7)
	Saskatchewan		381 (3.1)
Housing problems	No		10,192 (83.1)
	Yes		2,080 (16.9)
Urban/rural status	Rural		1,677 (13.7)
	Urban		10,595 (86.3)
Body mass index	Normal		3,526 (28.7)
	Underweight		112 (0.9)
	Overweight		5,171 (42.1)
	Obese		3,464 (28.2)

(Continued)

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Table 1. *Continued*

Independent Variables		Frequency (%)
Inactivity	<1 hour	212 (1.7)
	1 hour but less than 2 hours	1,169 (9.5)
	2 hours but less than 4 hours	4,682 (38.2)
	≥4 hours	6,209 (50.6)
Smoking	Smoked in the last 30 days	725 (5.9)
	Has not smoked in the last 30 days	11,547 (94.1)
Restless sleep	All of the time (5-7 days)	1,975 (16.1)
	Occasionally (3-4 days)	2,314 (18.9)
	Some of the time (1-2 days)	3,400 (27.7)
	Rarely or never (less than 1 day)	4,584 (37.3)
Appetite	Poor	212 (1.7)
	Fair	727 (5.9)
	Good	4,553 (37.1)
	Very good	6,780 (55.3)
Skipped meals	Sometimes to always	2,200 (17.9)
	Rarely or never	10,072 (82.1)
Pain	None	7,112 (57.9)
	Mild	1,858 (15.1)
	Moderate	2,715 (22.1)
	Severe	587 (4.8)

Note: CLSA = Canadian Longitudinal Study on Aging; OARS ADL = Older Americans Resources and Services Activities of Daily Living.

degree of research support because of their overlap in occurrence and symptoms. These entail: (1) a cardiovascular and metabolic cluster (n = 5,112), including heart disease, diabetes, and high blood pressure (Cornell, Pugh, & Williams, 2007; Freund, Kuna, Ose, Szecsenyi, & Peters-Klimm, 2012; Holden et al., 2011; Kirchberger et al., 2012; Ng, Holden, & Sun, 2012; Schafer et al., 2010); (2) a musculskeletal cluster (n = 2,245) composed of osteoarthritis, osteoporosis, and chronic lower back problem (Holden et al., 2011; Schafer et al., 2010); and (3) a mental health cluster (1,156), given that mood disorder, anxiety disorder, and migraine headache are often found to co-occur (Kirchberger et al., 2012; Schafer et al., 2010) (Table 2).

Results

Two or More Multimorbid Conditions Logistic Regression Analysis

Only results in the final model are presented for each subsequent section. Among the sample of persons 65 years of age or older who had two or more chronic conditions, healthy aging was found to be associated with 14 variables (model χ^2 =1,175.89, $p < 0.001$). For the socio-demographic model, a negative association was found for being male rather than female (OR = 0.50, $p < 0.001$, confidence interval [CI] 0.43–0.58); positive associations for age (OR = 1.03, CI 1.02–1.05, $p < 0.001$); education level: trade certificate or diploma (OR = 1.24, CI 1.06–1.44, $p < 0.05$), bachelor's degree (OR = 1.37, CI 1.11–1.69, $p < 0.01$), university or certificate above bachelor's degree (OR = 1.71, CI 1.34–2.17, $p < 0.001$), compared with no post-secondary degree or certificate; household income: $50,000–$99,999 (OR = 1.47, CI 1.13–1.92, $p < 0.01$), $100,000–$149,999 (OR = 1.98, CI 1.36–2.89, $p < 0.001$), $150,000 and higher (OR = 1.88, CI 1.16–2.90, $p < 0.01$), compared with less than $20,000; and an inverse association with one provincial contrast, Saskatchewan (OR = 0.62, CI 0.43–0.90, $p < 0.05$), compared with Ontario. Among the social/environmental model, healthy aging was associated with number of friends (OR = 1.02, CI 1.01–1.03, $p < 0.001$), and number of relatives (OR = 1.01, CI 1.00–1.01, $p < 0.05$). Turning to the behavioural/lifestyle model, the factors associated with healthy aging include both positive and inverse associations with body mass index: overweight (OR = 1.25, CI 1.05–1.49, $p < 0.05$), obese (OR = 0.78, CI 0.65–0.93, $p < 0.01$), compared with normal weight; and positive associations with not smoking (OR = 1.40, CI 1.11–1.77, $p < 0.01$), compared with smoking; restless sleep: occasionally (OR = 1.52, CI 1.24–1.86, $p < 0.001$), some of the time (OR = 1.56, CI 1.29–1.88, $p < 0.001$), rarely or never (OR = 1.67, CI 1.39–1.99, $p < 0.001$), compared with all of the time; and appetite: good (OR = 2.20, CI 1.53–3.16, $p < 0.001$), very good (OR = 2.53, CI 1.75–3.65, $p < 0.001$), compared with poor. The illness context model variables inversely associated with healthy aging was pain: mild (OR = 0.78, CI 0.64–0.95, $p < 0.05$), moderate (OR = 0.56, CI 0.47–0.65, $p < 0.001$), severe (OR = 0.42,CI 0.33–0.53, $p < 0.001$), compared with none; the OARS physical activities of daily living scale was positively associated (OR = 1.30, CI 1.22–1.38, $p < 0.001$); and the multimorbidity 27 scale exhibited an inverse relationship with healthy aging (OR = 0.80, CI 0.77–0.82, $p < 0.001$) (Table 3).

Cardiovascular and Metabolic Cluster Logistic Regression Analysis

Ten variables were found to be associated with healthy aging for the sample of persons 65 years of age and older who had two or more of

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Table 2. Hierarchical logistic regression of perceived healthy aging among multimorbid (≥2 conditions, age ≥65), CLSA unweighted (n = 17,148)

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
1) Sociodemographic model				
Age	1.02***	1.02***	1.01*	1.03***
	(1.01-1.03)	(1.01-1.03)	(1.00-1.03)	(1.02-1.05)
Gender—male (female—ref)	0.69***	0.69***	0.66***	0.50***
	(0.60-0.79)	(0.60-0.79)	(0.57-0.76)	(0.43-0.58)
Education level (no post-sec. deg., cert., or dipl.—ref)				
Trade certificate or diploma	1.24**	1.26**	1.19*	1.24*
	(1.08-1.44)	(1.09-1.45)	(1.02-1.38)	(1.06-1.44)
Bachelor's degree	1.55***	1.58***	1.40**	1.37**
	(1.27 to 1.89)	(1.30 to 1.93)	(1.14 to 1.71)	(1.11 to 1.69)
University or certificate above bachelor's degree	1.93***	1.97***	1.70***	1.71***
	(1.54-2.42)	(1.57-2.47)	(1.35-2.15)	(1.34-2.17)
Household income (<$20,000 per year—ref)				
$20,000-$49,999	1.49***	1.47***	1.32*	1.19
	(1.20-1.85)	(1.19-1.82)	(1.05-1.65)	(0.94-1.51)
$50,000-$99,999	2.12***	2.09***	1.76***	1.47**
	(1.66 -2.70)	(1.64-2.67)	(1.36-2.26)	(1.13-1.92)
$100,000-$149,999	3.24***	3.19***	2.57***	1.98***
	(2.27-4.61)	(2.19-4.44)	(1.79-3.70)	(1.36-2.89)
≥$150,000	2.85***	2.81***	2.29***	1.88**
	(1.84-4.41)	(1.81-4.35)	(1.46-3.59)	(1.16-2.90)
Missing	1.58**	1.57**	1.36*	1.24
	(1.20-2.10)	(1.19-2.08)	(1.02-1.82)	(0.92-1.69)
Marital status—married or common-law (not married—ref)	1.19*	1.16	1.05	1.06
	(1.03-1.38)	(1.00-1.34)	(0.91-1.23)	(0.90–1.24)
Immigration status—immigrant (born in Canada–ref)	.90	.92	.91	.85
	(0.76-1.06)	(0.78-1.09)	(0.76-1.07)	(0.71-1.02)
Province (Ontario—ref)				
Alberta	0.81	0.81	0.84	0.84
	(0.64-0.104)	(0.63–1.03)	(0.65–1.08)	(0.64–1.09)
British Columbia	1.04	1.05	1.02	1.00
	(0.84-1.28)	(0.85-1.29)	(0.82-1.26)	(0.80-1.25)
Manitoba	0.91	0.89	0.93	0.88
	(0.71-1.15)	(0.70-1.13)	(0.72-1.19)	(0.68-1.14)
New Brunswick	.85	.81	.77	.79
	(0.60-1.20)	(0.57-1.15)	(0.54-1.11)	(0.54-1.14)
Newfoundland and Labrador	0.93	0.91	0.82	0.79
	(0.70-1.22)	(0.69-1.20)	(0.62-1.09)	(0.59-1.06)
Nova Scotia	1.04	1.03	.99	.95
	(0.81-1.33)	(0.81-1.33)	(0.76-1.27)	(0.73-1.24)
Prince Edward Island	1.46	1.34	1.30	1.34
	(0.91-2.32)	(0.84-2.15)	(0.80-2.10)	(0.82-2.20)

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Table 2. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Quebec	1.10	1.12	1.08	1.12
	(0.90-1.34)	(0.91-1.36)	(0.88-1.32)	(0.90-1.39)
Saskatchewan	0.78	0.75	0.70*	0.62*
	(0.55-1.11)	(0.53-1.06)	(0.49-0.99)	(0.43-0.90)
2) Social/environmental model				
Number of friends		1.02***	1.02**	1.02**
		(1.01-1.04)	(1.01-1.03)	(1.01-1.03)
Number of relatives		1.00	1.00	1.01*
		(1.00-1.01)	(1.00-1.00)	(1.00-1.01)
Housing problems—yes (no housing problems—ref)		0.82*	0.90	1.04
		(0.70-0.96)	(0.76-1.06)	(0.88-1.23)
Urban/rural status—urban (rural—ref)		0.87	0.93	0.95
		(0.72-1.05)	(0.77-1.13)	(0.78-1.16)
3) Behavioral/lifestyle model				
BMI (normal—ref)				
Underweight			0.72	0.66
			(0.40-1.33)	(0.35-1.25)
Overweight			1.10	1.25*
			(0.93-1.31)	(1.05-1.49)
Obese			0.56***	0.78**
			(0.47-0.66)	(0.65-0.93)
Inactivity (sitting <1 hour—ref)				
1 hour but less than 2 hours			1.04	1.13
			(0.59-1.84)	(0.63-2.03)
2 hours but less than 4 hours			1.09	1.17
			(0.64-1.87)	(0.67-2.01)
≥ 4 hours			.65	.76
			(0.38-1.10)	(0.44-1.31)
Smoking—not in the last 30 days (smoked in the last 30 days—ref)			1.50***	1.40**
			(1.20-1.87)	(1.11-1.77)
Restless sleep (all of the time 5-7 days—ref)				
Occasionally (3-4 days)			1.79***	1.52***
			(1.48-2.17)	(1.24-1.86)
Some of the time (1-2 days)			1.94***	1.56***
			(1.62 to 2.32)	(1.29 to 1.88)
Rarely or never (<1 day)			2.15***	1.67***
			(1.81-2.54)	(1.39-1.99)
Appetite (poor—ref)				
Fair			1.34	1.16
			(0.93-1.95)	(0.78-1.72)
Good			2.95***	2.20***
			(2.10-4.15)	(1.53-3.16)

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Table 2. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Very good			3.75***	2.53***
			(2.66 to 5.30)	(1.75 to 3.65)
Skipped meals—rarely or never (sometimes/often—ref)			1.20*	1.09
			(1.02-1.40)	(0.92-1.28)
4) Illness context				
Pain (none—ref)				
Mild				0.78*
				(0.64-0.95)
Moderate				0.56***
				(0.47-0.65)
Severe				0.42***
				(0.33-0.53)
OARS Physical Activities of Daily Living scale				1.30***
				(1.22-1.38)
Multimorbidity 27 scale				0.80***
				(0.77-0.82)
Model χ^2 (*df*)	210.64***	244.08***	678.80***	1175.89***
	(21)	(25)	(39)	(44)

Note. *p < 0.05, **p < 0.01, ***p < 0.001.
Ref = reference category; CLSA = Canadian Longitudinal Study on Aging; CI = confidence interval; OARS = Older Americans Resources and Services; BMI = body mass index.

the following chronic conditions: heart disease, diabetes, and high blood pressure (model $\chi^2 = 369.73$, $p < 0.001$). For the socio-demographic model, these factors were age (OR = 1.02, CI 1.00–1.04; $p < 0.05$); an inverse association with being male rather than female (OR = 0.59, CI 47–0.74, p <0.001); and positive associations with education level: university or certificate above bachelor's degree (OR = 1.51, CI 1.04–2.19, $p < 0.05$), compared with no post-secondary degree or certificate; and, household income: $50,000–$99,999 (OR = 1.78, CI 1.20–2.64, $p < 0.01$), $100,000–$149,999 (OR = 1.77, CI 1.02–3.07, $p < 0.05$), compared with less than $20,000. Variables associated with healthy aging among the behavioural/lifestyle model included restless sleep: occasionally (OR = 1.37, CI = 1.00–1.84), $p < 0.05$, some of the time (OR = 1.53, CI 1.15–2.03, $p < 0.01$), rarely or never (OR = 1.53, CI 1.18–2.0, $p < 0.01$), compared with all of the time; and better appetite: good (OR = 2.33, $p < 0.001$, CI 1.38–3.92, $p < 0.01$) or very good (OR = 2.64, CI 1.56–4.46, $p < 0.001$), compared with poor. The illness context model factors associated with healthy aging were less pain: moderate (OR = 0.70, CI 0.54–0.88, $p < 0.00$), severe (OR = 0.42, CI 0.30–0.59, $p < 0.001$), compared with none; greater functional status using the OARS physical activities of daily living scale (OR = 1.27, CI 1.16–1.39, $p < 0.001$); and the cardiovascular and metabolic comorbidity scale (OR = 0.85, CI 0.81–0.89, $p <$ 0.001) (Table 4).

Musculoskeletal Cluster Logistic Regression Analysis

For the sample of persons 65 years of age and older who had two or more of the following chronic conditions: osteoarthritis, osteoporosis, and chronic lower back problems, healthy aging was also found to be associated with nine variables (model $\chi^2 =$ 227.71, $p < 0.001$). In the socio-demographic model, healthy aging was positively associated with age (OR = 1.04, CI 1.01–1.07, $p <$ 0.05); inversely associated with being male rather than female (OR = 0.67, CI 0.46–0.96, $p < 0.05$); and being an immigrant (OR = 0.53, CI 0.36–0.78, $p < 0.01$), compared with being native born. The behavioural/lifestyle model factors associated with healthy aging were high body mass index: being obese (OR = 0.55, CI 0.36–0.84, $p < 0.01$), compared with being a normal weight; not smoking (OR 1.72, CI 1.01–2.94, $p < 0.05$); restless sleep: occasionally (OR 1.74, CI 1.09–2.79, $p < 0.05$), some of the time (OR = 1.72, CI 1.12–2.66, $p < 0.05$), rarely, or never (OR = 1.74, CI 1.16–2.61, $p < 0.01$), compared with all of the time; and better appetite: fair (OR = 0.28, CI 0.10–0.77, p 0.05), compared with poor. Variables associated with healthy aging in the illness context model included less pain: moderate (OR = 0.58, CI 0.40–0.86, $p <$ 0.01), severe (OR = 0.51, CI 0.30–0.87, $p < 0.05$), compared with none; greater functional ability based on the OARS physical activities of daily living scale (OR = 1.32, CI 1.16–1.51, $p < 0.001$); and inversely associated with the musculoskeletal comorbidity scale (OR = 0.85, CI 0.79–0.90, $p < 0.001$) (Table 5).

Mental Health Cluster Logistic Regression Analysis

Among the sample of persons 65 years of age or older who had two or more of the following chronic conditions: anxiety disorder, mood disorder, and migraine headache, healthy aging was found to be associated with 11 variables (model $\chi^2 = 162.56$, $p < 0.001$).

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Table 3. Hierarchical logistic regression of perceived healthy aging among multimorbid (≥ 2 conditions, ≥ 65 years of age) cardiovascular and metabolic cluster, CLSA unweighted (n = 5,112)

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
1) Sociodemographic model				
Age	1.02*	1.02*	1.01	1.02*
	(1.00-1.04)	(1.00-1.04)	(0.99-1.03)	(1.00-1.04)
Gender—male (female—ref)	0.89	0.89	0.81*	0.59***
	(0.73-1.09)	(0.72-1.09)	(0.65-1.00)	(0.47-0.74)
Education level (no post-sec. deg., cert., or dipl.—ref)				
Trade certificate or diploma	1.14	1.15	1.07	1.11
	(0.92-1.41)	(0.93-1.43)	(0.85-1.33)	(0.88-1.39)
Bachelor's degree	1.43*	1.45*	1.28	1.30
	(1.05-1.94)	(1.07-1.97)	(0.93-1.75)	(0.94-1.80)
University or certificate above bachelor's degree	1.63**	1.67**	1.46*	1.51*
	(1.15-2.33)	(1.17-2.38)	(1.02-2.11)	(1.04-2.19)
Household income (< $20,000 per year—ref)				
$20,000-$49,999	1.48*	1.48*	1.36	1.29
	(1.08-2.04)	(1.07-2.03)	(0.98-1.90)	(0.91-1.82)
$50,000-$99,999	2.31***	2.32***	2.07***	1.78**
	(1.60-3.32)	(1.61-3.35)	(1.41-3.03)	(1.20-2.64)
$100,000-$149,999	2.60***	2.63***	2.26**	1.77*
	(1.55-4.35)	(1.57-4.43)	(1.32-3.85)	(1.02-3.07)
≥$150,000 and over	2.34**	2.34**	2.00*	1.75
	(1.24-4.35)	(1.25-4.39)	(1.05-3.81)	(0.91-3.39)
Missing	1.50	1.53*	1.45	1.40
	(1.00 to 2.27)	(1.01 to 2.33)	(.94 to 2.32)	(.90 to 2.19)
Marital status—married or common-law (not married—ref)	1.05	1.02	0.96	0.96
	(.84 to 1.32)	(.81 to 1.28)	(.76 to 1.21)	(.76 to 1.22)
Immigration status—immigrant (born in Canada—ref)	1.07	1.10	1.08	1.05
	(0.83-1.39)	(0.84-1.43)	(0.82-1.42)	(0.79-1.39)
Province (Ontario—ref)				
Alberta	0.76	0.78	0.82	0.81
	(0.52-1.10)	(0.53-1.13)	(0.56-1.20)	(0.54-1.20)
British Columbia	1.03	1.04	1.00	0.95
	(0.74-1.43)	(0.75-1.45)	(0.71-1.40)	(0.67-1.34)
Manitoba	0.91	0.91	0.91	0.87
	(0.64-1.30)	(0.64-1.31)	(0.63-1.32)	(0.59-1.27)
New Brunswick	0.70	0.67	0.64	0.64
	(0.42-1.16)	(0.40-1.11)	(0.38-1.08)	(0.37-1.11)
Newfoundland and Labrador	0.95	0.94	0.86	0.83
	(0.62-1.43)	(0.62-1.44)	(0.56-1.32)	(0.53-1.30)
Nova Scotia	1.07	1.08	1.00	0.94
	(0.74-1.55)	(0.74-1.56)	(0.68-1.46)	(0.64-1.38)
Prince Edward Island	1.34	1.22	1.16	1.14
	(0.67-2.68)	(0.61-2.44)	(0.57-2.35)	(0.55-2.37)

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Table 3. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Quebec	1.13	1.15	1.10	1.14
	(0.84-1.52)	(0.85-1.56)	(0.80-1.50)	(0.82-1.57)
Saskatchewan	0.85	0.86	0.77	0.69
	(0.49-1.49)	(0.49-1.50)	(0.43-1.35)	(0.38-1.24)
2) Social/environmental model				
Number of friends		1.02*	1.02*	1.01
		(1.00-1.03)	(1.00-1.03)	(1.00-1.03)
Number of relatives		1.00	1.00	1.00
		(1.00-1.01)	(1.00-1.01)	(1.00-1.01)
Housing problems—yes (no housing problems—ref)		0.84	0.89	1.00
		(0.67-1.07)	(0.69-1.14)	(0.78-1.30)
Urban/rural status—urban (rural—ref)		.77	.83	.87
		(0.57-1.03)	(0.61-1.11)	(0.64-1.18)
3) Behavioral/lifestyle model				
BMI (normal—ref)				
Underweight			1.47	1.55
			(0.22-9.49)	(0.23-10.52)
Overweight			1.33	1.34
			(.99 to 1.77)	(1.00 to 1.81)
Obese			0.69*	0.80
			(0.53-0.92)	(0.60-1.07)
Inactivity (sitting < 1 hour—ref)				
1 hour but less than 2 hours			1.83	1.89
			(0.84-4.02)	(0.84-4.24)
2 hours but less than 4 hours			1.91	1.90
			(0.93-3.91)	(0.91-3.97)
≥4 hours			1.19	1.33
			(0.59-2.40)	(0.64-2.74)
Smoking—not in the last 30 days (smoked in the last 30 days—ref)			1.54*	1.43
			(1.10-2.17)	(1.00-2.04)
Restless sleep (all of the time 5-7 days—ref)				
Occasionally (3-4 days)			1.55**	1.37*
			(1.15-2.07)	(1.00-1.84)
Some of the time (1-2 days)			1.82***	1.53**
			(1.38-2.39)	(1.15-2.03)
Rarely or never (less than 1 day)			1.84***	1.53**
			(1.43-2.38)	(1.18-2.00)
Appetite (poor—ref)				
Fair			1.60	1.49
			(0.93-2.78)	(0.83-2.63)
Good			2.80***	2.33**
			(1.71-4.58)	(1.38-3.92)

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Table 3. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Very good			3.47***	2.64***
			(2.11-5.71)	(1.56-4.46)
Skipped meals—rarely or never (sometimes/often—ref)			1.11	1.02
			(0.87-1.40)	(0.80-1.31)
4) Illness context				
Pain (none—ref)				
Mild				0.95
				(0.70-1.30)
Moderate				0.70**
				(0.54-0.88)
Severe				0.42***
				(0.30-0.59)
OARS Physical Activities of Daily Living scale				1.27***
				(1.16-1.39)
Cardiovascular and Metabolic Comorbidity scale				0.85***
				(0.81-0.89)
Model χ^2 (*df*)	71.40***	83.62***	227.02***	369.73***
	(21)	(25)	(39)	(44)

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Ref = reference category; CLSA = Canadian Longitudinal Study on Aging; CI = confidence interval; OARS = Older Americans Resources and Services; BMI = body mass index.

For the socio-demographic model, healthy aging was positively associated with age (OR = 1.08, CI 1.03–1.13, $p < 0.01$); inversely with being male rather than female (OR = 0.49, CI 0.30–0.80, $p < 0.01$); and Province: Newfoundland and Labrador (OR = 0.38, CI 0.16–0.92, $p < 0.05$), rather than Ontario. Healthy aging was also positively associated with the social/environmental model factors, including: number of friends (OR = 1.07, CI 1.01–1.14, $p < 0.05$) and urban status (OR = 1.87, CI 1.05–3.34, $p < 0.05$), compared with rural. The behavioural/lifestyle model factors associated with healthy aging were high body mass index: being obese (OR = 0.54, CI 0.31–0.93, $p < 0.05$), compared with being normal weight; restless sleep: occasionally (OR = 2.68, CI 1.42–5.08, $p < 0.01$), rarely or never (OR = 1.80, CI 1.06–3.06, $p < 0.05$); and better appetite: very good (OR = 3.10, CI 1.27–7.54, $p < 0.05$), compared with poor. Among the illness context variables, healthy aging was inversely associated with a moderate level of pain (OR = 0.61, CI 0.38–0.99, $p < 0.05$) compared to none; positively associated with the OARS physical activities of daily living scale (OR = 1.47, CI 1.24–1.74, $p < 0.001$); and inversely with the mental health comorbidity scale (OR = 0.89, CI 0.82–0.97, $p < 0.05$).

Discussion

The concurrence of two or more chronic illnesses is increasingly common among older adults, and presents a set of adversities that limit physiological, psychological and social dimensions of aging (Agborsangaya, Ngwakongnwi, et al., 2013). This article extends our understanding of how and why some individuals are able to perceive themselves as aging in a healthy manner based on an examination of social determinants of health and health behaviours. Perceptions of healthy aging, similar to research using self-rated health, can be a powerful global indicator of health-related quality of life, and may be indicative of resilience among persons facing the everyday adversities connected to multimorbidity (Galenkamp et al., 2011). It is argued that appraisals of healthy aging, albeit not well understood, reflect comparisons with other older adults, but also capture elements of process linked to aging. Using baseline data from the CLSA, this study examined several major health behaviours that have been associated with morbidity, mortality, and health-related quality of life. Our analyses focus on several types of multimorbidity adversity: (1) older persons reporting multimorbidity – operationalized as two or more conditions; and 2) those reporting two or more illnesses that fall within one of the three major identified clusters of illnesses.

Positive appraisals of healthy aging in the face of multimorbidity adversity are strongly related to several major health behaviours, although both similarities and differences occur across the multimorbidity clusters under examination. For multimorbidity and the three illness clusters, healthy aging is consistently associated with not smoking (except for the mental health cluster), not being obese (except the cardiovascular and metabolic cluster), better sleep, and a better appetite, after adjusting for all variables. Smoking habits, obesity, and food security (availability, access, utilization, stability) represent three health behaviours and/or contexts that typically find their place in health behaviour and aging research (Kendig et al., 2014; Short & Mollborn, 2015) and associated research focusing on multimorbidity risk (Agborsangaya, Ngwakongnwi,

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Table 4. Hierarchical logistic regression of perceived healthy aging among multimorbid (≥2 conditions, ≥65 years of age), musculoskeletal cluster, CLSA unweighted (n = 2,245)

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
1) Sociodemographic model				
Age	1.02	1.02	1.01	1.04*
	(1.00-1.05)	(0.99–1.05)	(0.98–1.04)	(1.01–1.07)
Gender—male (female—ref)	0.74	0.73	0.74	0.67*
	(0.53-1.03)	(0.52-1.01)	(0.52-1.05)	(0.46-0.96)
Education level (no post-sec. deg., cert., or dipl.—ref)				
Trade certificate or diploma	1.20	1.20	1.06	1.11
	(0.86-1.68)	(0.86-1.67)	(0.74-1.50)	(0.77-1.60)
Bachelor's degree	1.47	1.47	1.30	1.35
	(0.93-2.32)	(0.93-2.32)	(0.81-2.11)	(0.82-2.21)
University or certificate above bachelor's degree	1.44	1.51	1.30	1.34
	(0.85-2.42)	(0.89-2.55)	(0.75-2.24)	(0.76-2.34)
Household income (<$20,000 per year—ref)				
$20,000-$49,999	1.53	1.53	1.30	1.16
	(0.94-2.49)	(0.94-2.51)	(0.77-2.19)	(0.67-2.01)
$50,000-$99,999	2.29**	2.28**	1.80	1.42
	(1.30-4.04)	(1.29-4.02)	(0.99-3.28)	(0.76-2.67)
$100,000-$149,999	2.57*	2.51*	2.09	1.40
	(1.15-5.71)	(1.13-5.60)	(0.90-4.85)	(0.58-3.34)
≥$150,000	11.82**	11.67**	6.64*	4.76
	(1.99-70.29)	(1.96-69.44)	(1.09-40.65)	(0.77-29.53)
Missing	1.54	1.55	1.21	1.09
	(0.83-2.86)	(0.84-2.88)	(0.63-2.33)	(0.55-2.17)
Marital status—married or common-law (not married—ref)	1.11	1.09	1.06	1.13
	(0.80-1.54)	(0.79-1.52)	(0.75-1.50)	(0.79-1.63)
Immigration status—immigrant (born in Canada—ref)	0.64*	0.63*	0.58**	0.53**
	(0.45-0.91)	(0.44-0.90)	(0.40-0.84)	(0.36-0.78)
Province (Ontario—ref)				
Alberta	0.84	0.85	0.85	0.75
	(0.47-1.49)	(0.48-1.52)	(0.46-1.56)	(0.40-1.42)
British Columbia	0.68	0.69	0.66	0.63
	(0.43-1.06)	(0.44-1.09)	(0.41-1.05)	(0.39-1.03)
Manitoba	0.74	0.74	0.71	0.60
	(0.43-1.27)	(0.43-1.28)	(0.40-1.26)	(0.33-1.09)
New Brunswick	0.85	0.87	0.72	0.83
	(0.37-1.96)	(0.37-2.01)	(0.30-1.72)	(0.33-2.11)
Newfoundland and Labrador	0.59	0.60	0.58	0.45
	(0.34-1.04)	(0.34-1.06)	(0.32-1.04)	(0.24-0.84)
Nova Scotia	1.34	1.36	1.17	1.15
	(0.70-2.59)	(0.71-2.63)	(0.59-2.30)	(0.57-2.32)
Prince Edward Island	0.94	0.93	1.03	0.96
	(0.34-2.60)	(0.33-2.58)	(0.35-3.03)	(0.32-2.93)

(Continued)

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Table 4. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Quebec	0.87	0.90	0.75	0.84
	(0.54-1.39)	(0.56-1.45)	(0.46-1.23)	(0.50-1.42)
Saskatchewan	0.87	0.90	0.76	0.62
	(0.36-2.08)	(0.37-2.17)	(0.31-1.90)	(0.24-1.60)
2) Social/environmental model				
Number of friends		1.01	1.00	1.00
		(0.98-1.03)	(0.98-1.03)	(0.97-1.02)
Number of relatives		1.00	1.00	1.00
		(1.00-1.01)	(0.99-1.01)	(0.99-1.01)
Housing problems—yes (no housing problems—ref)		0.69*	0.75	0.87
		(.50 to .96)	(.53 to 1.07)	(.60 to 1.25)
Urban/rural status—urban (rural—ref)		0.93	0.99	1.13
		(0.59-1.45)	(0.62-1.58)	(0.70-1.82)
3) Behavioral/lifestyle model				
BMI (normal—ref)				
Underweight			1.11	1.09
			(0.27-4.44)	(0.25-4.71)
Overweight			0.78	0.94
			(0.53-1.17)	(0.62-1.42)
Obese			0.38***	0.55**
			(0.25-0.56)	(0.36-0.84)
Inactivity (sitting < 1 hour—ref)				
1 hour but less than 2 hours			0.92	0.87
			(0.21-4.08)	(0.19-4.02)
2 hours but less than 4 hours			0.93	0.85
			(0.23-3.83)	(0.20-3.61)
≥4 hours			0.63	0.65
			(0.16-2.54)	(0.15-2.72)
Smoking—not in the last 30 days (smoked in the last 30 days—ref)			1.88*	1.72*
			(1.13-3.15)	(1.01-2.94)
Restless sleep (all of the time 5-7 days—ref)				
Occasionally (3-4 days)			2.12**	1.74*
			(1.35-3.34)	(1.09-2.79)
Some of the time (1-2 days)			2.15***	1.72*
			(1.42-3.25)	(1.12-2.66)
Rarely or never (< 1 day)			2.11***	1.74**
			(1.43-3.11)	(1.16-2.61)
Appetite (poor—ref)				
Fair			0.41	0.28*
			(0.16-1.06)	(0.10-0.77)
Good			1.04	0.72
			(0.43-2.51)	(0.28-1.84)

(Continued)

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Table 4. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Very good			1.23	0.79
			(.51 to 3.00)	(.31 to 2.03)
Skipped meals—rarely or never (sometimes/often—ref)			1.37	1.29
			(0.95-1.96)	(0.88-1.87)
4) Illness context				
Pain (none—ref)				
Mild				0.83
				(0.51-1.34)
Moderate				0.58**
				(0.40-0.86)
Severe				0.51*
				(0.30-0.87)
OARS Physical Activities of Daily Living scale				1.32***
				(1.16-1.51)
Musculoskeletal Comorbidity scale				0.85***
				(0.79-0.90)
Model χ^2 (*df*)	46.69**	52.12**	152.38***	227.71***
	(21)	(25)	(39)	(44)

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Ref = reference category; CLSA = Canadian Longitudinal Study on Aging; CI = confidence interval; OARS = Older Americans Resources and Services; BMI = body mass index.

et al., 2013; Canizares et al., 2017; Skivington, Katikireddi, Leyland, Hunt, & Mercer, 2015). Smoking can also negatively affect appraisals of healthy aging and resilience among persons with multiple chronic illnesses, perhaps because of its addictive properties. Obesity increases the seriousness of related symptoms, and illness coping responses (Agborsangaya, Ngwakongnwi, et al., 2013; Canizares et al., 2017; Kendig et al., 2014). We also found that a good appetite augments positive appraisals which is consistent with research that establishes the importance of food security and multimorbidity risk in old age (Sharkey, 2003). Furthermore, although less studied, sleep quality also enhances a sense of healthy aging among those with multimorbidity and underscores its influence for patterns of recovery and coping that parallels other research (Ezeamama et al., 2016; Ong et al., 2015). These findings concur with many of the associations uncovered in other studies of the role of health behaviours in enhancing appraisals of healthy aging among multimorbid older adults (Stewart & Yuen, 2011; Windle, 2012; Wister, Cosco, et al., 2020).

It is well established that lifestyle behaviours tend to be routinized and develop over the life course of individuals. Given their salience as predictors of perceptions of healthy aging, our findings elucidate the ways in which health and healthy behaviours can be understood within a social determinants and health behaviour framework (Short & Mollborn, 2015) and in terms of understanding resilience as a process and the centrality of resources. Health behaviours are conceptualized as rooted in structural and individual opportunities and constraints forming salient resources that, if available and accessed, can be used to offset the deleterious aspects of multimorbidity and clusters of illnesses in older adults (Wister et al., 2018). This adversity entails symptoms that restrict functioning; cause pain, stress, anxiety, and discomfort, and restrict the maintenance of healthy living more generally (Ong et al., 2015; Sells et al., 2009).

Although we examine the role of health behaviours on perceptions of healthy aging among multimorbid individuals, our results are remarkedly consistent with research on lifestyle predictors of multiple chronic illnesses. For example, Skivington et al. (2015) found support for very similar behavioural lifestyle factors on multimorbidity (two or more conditions) in a longitudinal study conducted in Scotland. After controlling for socio-demographic covariates, the authors found that multimorbidity was higher among smokers than among non-smokers (OR 1.38, 95% CI 1.20–1.60); for those with BMI 30–35 (OR 1.57, 95% CI 1.22–2.01) and > 35 (OR 2.21, 95% CI 1.40–3.48) compared with those with BMI 20–25; for those with poor diet (OR 1.28, 95% CI 1.05–1.57); and for those in the lowest compared with the highest income tertile (OR 1.29, 95% CI 1.03–1.54). These similarities reinforce the key role that health behaviours play in shaping healthy aging and multimorbidity coping processes.

The absence of support for the effect of physical inactivity on perceptions of healthy aging, while seemingly counterintuitive, is consistent with other multimorbidity research, even longitudinal studies (e.g., Autenrieth et al., 2013; Canizares et al., 2017). One explanation is that long-term inactivity may be more important for health outcomes, and/or more relevant for particular subgroups of older adults, such that associations are not supported after adjusting for socio-demographic and social/environmental variables.

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Table 5. Hierarchical logistic regression of perceived healthy aging among multimorbid (≥2 conditions, ≥65), mental health cluster, CLSA unweighted (n = 1,156)

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
1) Sociodemographic model				
Age	1.04*	1.04*	1.04*	1.08**
	(1.00-1.08)	(1.00-1.08)	(1.00-1.09)	(1.03-1.13)
Gender—male (female—ref)	0.56*	0.62*	0.60*	0.49**
	(.37 to .86)	(.40 to .96)	(.38 to .95)	(.30 to .80)
Education level (no post-sec. deg., cert., or dipl—ref)				
Trade certificate or diploma	1.33	1.34	1.33	1.43
	(0.87-2.03)	(0.87-2.06)	(0.84-2.12)	(0.88-2.32)
Bachelor's degree	1.70	1.72	1.64	1.67
	(0.95-3.05)	(0.95-3.11)	(0.87-3.08)	(0.87-3.20)
University or certificate above bachelor's degree	1.98*	1.92*	1.62	1.64
	(1.05-3.74)	(1.01-3.66)	(0.82-3.20)	(0.81-3.32)
Household income (<$20,000 per year—ref)				
$20,000-$49,999	1.05	.99	.90	.75
	(0.60-1.86)	(0.55-1.76)	(0.48-1.69)	(0.39-1.46)
$50,000-$99,999	1.38	1.26	1.05	0.85
	(0.71-2.70)	(0.64-2.50)	(0.51-2.16)	(0.40-1.82)
$100,000-$149,999	2.60	2.27	1.76	1.31
	(0.82-8.23)	(0.71-7.28)	(0.52-5.99)	(0.37-4.68)
≥$150,000	4.09	3.40	3.39	4.24
	(0.69-24.46)	(0.56-20.59)	(0.51-22.37)	(0.46-39.40)
Missing	0.97	0.98	0.77	0.76
	(0.46-2.08)	(0.46-2.11)	(0.34-1.78)	(0.32-1.84)
Marital status—married or common-law (not married—ref)	1.38	1.37	1.38	1.45
	(0.90-2.11)	(0.89-2.10)	(0.87-2.17)	(0.90-2.34)
Immigration status—immigrant (born in Canada—ref)	0.70	0.74	0.80	0.80
	(0.43-1.11)	(0.46-1.21)	(0.47-1.35)	(0.46-1.38)
Province (Ontario—ref)				
Alberta	0.71	0.71	0.83	0.76
	(0.32-1.58)	(0.32-1.60)	(0.34-2.01)	(0.30-1.93)
British Columbia	0.73	0.73	0.75	0.67
	(0.42-1.28)	(0.42-1.28)	(0.41-1.36)	(0.36-1.25)
Manitoba	0.62	0.61	0.64	0.62
	(0.31-1.28)	(0.30-1.26)	(0.29-1.37)	(0.28-1.39)
New Brunswick	.91	.90	.94	.98
	(0.27-3.01)	(0.27-3.07)	(0.25-3.59)	(0.23-4.15)
Newfoundland and Labrador	0.53	0.56	0.47	0.38*
	(0.25-1.15)	(0.26-1.22)	(0.20-1.09)	(0.16-0.92)
Nova Scotia	0.93	1.01	1.23	1.06
	(0.44-1.99)	(0.47-2.18)	(0.54-2.78)	(0.46-2.46)
Prince Edward Island	0.61	0.64	0.58	0.43
	(0.19-1.96)	(0.20-2.09)	(0.17-2.06)	(0.12-1.53)

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Table 5. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Quebec	1.13	1.31	1.14	1.21
	(0.61-2.07)	(0.70-2.44)	(0.60-2.20)	(0.61-2.40)
Saskatchewan	0.92	0.90	0.72	0.62
	(0.28-2.97)	(0.27-2.99)	(0.21-2.53)	(0.17-2.27)
2) Social/environmental model				
Number of friends		1.09**	1.07*	1.07*
		(1.03-1.15)	(1.01-1.13)	(1.01-1.14)
Number of relatives		1.00	1.00	1.01
		(1.00-1.01)	(1.00-1.01)	(1.00-1.01)
Housing problems—yes (no housing problems—ref)		0.92	1.01	1.17
		(0.61-1.41)	(0.65-1.59)	(0.73-1.87)
Urban/rural status–urban (rural—ref)		1.53	1.76	1.87*
		(0.90-2.59)	(1.00-3.10)	(1.05-3.34)
3) Behavioral/lifestyle model				
BMI (normal—ref)				
Underweight			0.59	0.72
			(0.06-5.44)	(0.08-6.71)
Overweight			0.76	0.83
			(0.44-1.31)	(0.47-1.46)
Obese			0.43**	0.54*
			(0.26-0.73)	(0.31-0.93)
Inactivity (sitting < 1 hour—ref)				
1 hour but less than 2 hours			0.81	0.62
			(0.10-6.83)	(0.07-5.56)
2 hours but less than 4 hours			0.74	0.54
			(0.10-5.53)	(0.07-4.24)
≥4 hours			0.48	0.41
			(0.06-3.53)	(0.05-3.16)
Smoking—not in the last 30 days (smoked in the last 30 days—ref)			1.08	0.97
			(0.56-2.07)	(0.49-1.92)
Restless sleep (all of the time 5-7 days—ref)				
Occasionally (3-4 days)			3.48***	2.68**
			(1.89-6.41)	(1.42-5.08)
Some of the time (1-2 days)			2.10**	1.64
			(1.23 to 3.58)	(.92 to 2.83)
Rarely or never (< 1 day)			2.27**	1.80*
			(1.37-3.75)	(1.06-3.06)
Appetite (poor—ref)				
Fair			0.97	0.83
			(0.39-2.41)	(0.32 -2.18)

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Table 5. *Continued*

	Model 1	Model 2	Model 3	Model 4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Good			2.12	1.82
			(0.93-4.83)	(0.76-4.35)
Very good			3.51**	3.10*
			(1.52-8.11)	(1.27-7.54)
Skipped meals—rarely or never (sometimes/often—ref)			1.09	.95
			(0.70-1.70)	(0.59-1.52)
4) Illness context				
Pain (none—ref)				
Mild				0.73
				(0.38-1.39)
Moderate				0.61*
				(0.38-0.99)
Severe				0.73
				(.36 to 1.48)
OARS Physical Activities of Daily Living scale				1.47***
				(1.24-1.74)
Mental Health Multimorbidity scale				0.89*
				(0.82-0.97)
Model χ^2 (*df*)	34.92*	48.59**	118.42***	162.56***
	(21)	(25)	(39)	(44)

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Ref = reference category; CLSA = Canadian Longitudinal Study on Aging; CI = confidence interval; OARS = Older Americans Resources and Services; BMI = body mass index.

Several socio-demographic resources were also associated with healthy aging among those with multimorbidity, indicating positive resilience. Older age, being female, and higher education and income (depending on cluster) lead to positive appraisals of healthy aging. These are in the expected direction except for age. It is possible that individuals compare themselves with others their own age and/or feel that they are aging better if they are older and have lived longer. Females consistently appraise their aging better than males, perhaps because of being greater users of health and community support systems, which mirrors other research related to multimorbidity and resilience (Canizares et al., 2017; Wister, Cosco, et al., 2020). Furthermore, social support fosters positive appraisals of healthy aging among those with two or more multimorbidity conditions, and those with a mental health cluster (but not for the other two clusters). Harnessing informal social support has been shown to help older people cope with multimorbidity (Sells et al., 2009; Wister, Cosco, Mitchell, Menec, & Fyffe, 2019; Zautra, Arewasikporn, & Davis, 2010); yet further research is needed to establish types (e.g., caregiving), and sources (spousal, other family, friends) of support on healthy aging, multimorbidity adaptation and resilience. Living in an urban environment fosters higher appraisals of healthy aging for the cardiovascular/metabolic and mental health clusters, which might be linked to access to health care resources. However, having housing problems was not inversely associated with healthy aging. Finally, as hypothesized, perceptions of lower pain levels, higher functional ability, and fewer concurrent chronic illnesses were consistently associated with healthy aging (Peters et al., 2019). Clearly, the illness context is central to adaptation and positive appraisals of healthy aging among multimorbid older adults.

Furthermore, the recent COVID-19 pandemic has likely magnified the adversity associated with multimorbidity among older adults by increasing levels of stress, anxiety, depression, social isolation, and the risk of developing the COVID-19 disease. A higher level of adversity can result in health behaviours being more influential resources in fostering healthy aging and resilience among older persons experiencing multimorbidity (Klasa, Galaitsi, Wister, & Linkov, 2021). Future research needs to also concentrate on the COVID-19 era to fully explore these empirical questions, given the unique illness context that the pandemic entails (Wister & Speechley, 2020).

The findings in this study are limited in serval ways. First, given that the available baseline CLSA data are cross-sectional, there is a possibility of reciprocal associations between behavioural lifestyle factors and positive perceptions of healthy aging. For example, appetite or sleep quality may not only affect adaptation to multiple chronic illnesses, they may also be influenced by the degree to which an individual is coping with illness. Longitudinal data can help to disentangle causal relationships among these factors to elucidate adaptation and resilience processes over the life course (Cosco et al., 2017). Second, the healthy aging measure is a single global indicator; therefore, additional measures need to be

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examined (see Stewart & Yuen, 2011; Windle, 2011). Further, the degree to which such a global measure captures resilience processes requires further attention, given that variable centered approaches to operationalization have been critiqued (Cosco et al., 2019). Third, research into healthy aging can be enhanced through the study of additional behavioural lifestyles and their interactions with other resources, which will help to map illness trajectories. Finally, this work needs to be applied to additional sub-groups, such as other disease clusters (Sells et al., 2009); different racial/ethnic groups; and marginalized communities (Quiñones, Liang, Bennett, Xu, & Ye, 2011; Wiles et al., 2012), and across a variety of environmental factors (Connelly et al., 2017; Ungar, 2011).

Health behaviours are central to perceptions of healthy aging, which in turn, are indicative of resilience in the face of illness. These processes are instrumental in the ability to cope, adapt, and bounce back from multiple chronic illnesses and are fundamental to healthy aging (Kendig et al., 2014; Windle, 2012). Our findings indicate that there are several mutable behavioural lifestyles that are differentially associated with positive illness appraisals. These key lifestyles behaviours appear to affect the degree to which older persons perceive that they are experiencing healthy aging, but are highly dependent on the nature, types and clustering of illnesses. This research serves as a launching point for future studies that can uncover the complexity of these relationships.

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Ethics Approval. This current project received ethics approval at two levels. Consent to participate was obtained for all participants under the CLSA harmonized multi-university ethics process approved by the Hamilton Integrated Research Ethics Board (HiREB), Hamilton Health Sciences/McMaster University. Written consent was obtained from all CLSA participants prior to enrollment. Individuals who were not deemed to be cognitively functional were excluded from the CLSA study. Simon Fraser University (SFU) was a participating institution in the CLSA data collection, and the SFU Office of Research Services Ethics Committee reviewed all consent material prior to data collection (SFU ORS #2010s0281).

References

Agborsangaya, C. B., Lau, D., Lahtinen, M., Cooke, T., & Johnson, J. (2013). Health-related quality of life and healthcare utilization in multimorbidity: Results of a cross-sectional survey. *Quality of Life Research*, **22**, 791–799. http://doi.org/10.1007/s11136-012-0214-7

Agborsangaya, C. B., Ngwakongnwi, E., Lahtinen, M., Cooke, T., & Johnson, J. (2013). Multimorbidity prevalence in the general population: The role of obesity in illness clustering. *BMC Public Health*, **13**, 1161. http://doi.org/10.1186/1471-2458-13-1161

Antonovsky, A. (1996). The salutogenic model as a theory to guide health promotion. *Health Promotion International*, **11**(1), 11–18.

Autenrieth, C., Kirchberger, I., Heier, M., Zimmermann, A. K., Peters, A., Döring, A., *et al.* (2013). Physical activity is inversely associated with multimorbidity in elderly men: Results from the KORA-Age Augsburg Study. *Preventive Medicine*, **57**, 17–19. http://doi.org/10.1016/j.ypmed.2013.02.014

Braverman, P., Egerter, S., & Williams, D. R. (2011). The social determinants of health: Coming of age. *Annual Review of Public Health*, **32**, 381–398.

Canizares, M., Hogg-Johnson, M., Gignac, M., Glazier, R., & Badley, E. (2017). Increasing trajectories of multimorbidity over time: Birth cohort differences and the role of changes in obesity and income. *Journal of Gerontology*, **73**(7), 1303–1314. http://doi.org/10.1093/geronb/gbx004

Connelly, E., Allen, C., Hatfield, K., Palma-Oliveira, J., Woods, D., & Linkov, I. (2017). Features of resilience. *Environmental Systems and Decisions*, **37**(1), 46–50.

Cornell, J., Pugh, J., & Williams, J. W. (2007). Multimorbidity clusters: Clustering binary data from multimorbidity clusters; clustering binary data from a large administrative medical database. *Journal of General Internal Medicine*, **22**(3), 419–424.

Cosco, T., Kaushal, A., Hardy, R., Richards, M., Kuh, D., & Stafford, M. (2017). Operationalising resilience in longitudinal studies: A systematic review of methodological approaches. *Journal of Epidemiology and Community Health*, **77**(1), 98–104.

Cosco, T., Kok, A., Wister, A., & Howse, K. (2019). Conceptualising and operationalising resilience in older adults. *Health Psychology and Behavioral Medicine*, **7**(1), 90–104.

Cosco, T. D., Wister, A., Brayne, C., & Howse, K. (2018). Psychosocial aspects of successful ageing and resilience: Critique, integration and implications. *Estudios de Psicología*, **39**, 248–266. http://doi.org/10.1080/02109395.2018.1493843

Ezeamama, A., Elkins, J., Simpson, C., Smith, S., Allegra, J., & Miles, T. (2016). Indicators of resilience and healthcare outcomes: Findings from the 2010 health and retirement survey. *Quality of Life Research*, **25**, 1007–1015. http://doi.org/10.1007/s11136-015-1144-y

Freund, T., Kuna, C. U., Ose, D., Szecsenyi, J., & Peters-Klimm, F. (2012). Patterns of multimorbidity in primary care patients at high risk of future hospitalization. *Population Health Management*, **15**(20), 119–124.

Galenkamp, H., Braam, A., Huisman, M., & Deeg, D. (2011). Somatic multimorbidity and self-rated health in the older population. *Journal of Gerontology*, **66B**(3), 380–386. http://doi.org/10.1093/geronb/gbr032

Guralnik, J. Simonsick, E. M., Ferrucci, L., Glynn, R. J., Berkman, L. F., Blazer, D. G., *et al.* (1994). A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *Journal of Gerontology*, **49**(2), 85–94. http://doi.org/10.1093/geronj/49.2.M85

Hamilton, N., & Bhatti, T. (1996). *Population health promotion: An integrated model of population health and health promotion*. Ottawa: Health Promotion Development Division.

Holden, L., Scuffdham, P. A., Hilton, M. F., Muspratt, A., Ng, S. K., & Whiteford, H. A. (2011). Patterns of multimorbidity in working Australians. *Population Health Metrics*, **9**(1), 15.

Idler, E., & Cartwright, K. (2018). What do we rate when we rate our health? Decomposing age-related contributions to self-rated health. *Journal of Health and Social Behavior*, **59**(1), 74–93.

Islam, M., Valderas, J., Yen, L., Dawda, P., Jowsey, T., & McRae, I. S. (2014). Multimorbidity and comorbidity of chronic diseases among the senior Australians: Prevalence and patterns. *PLoS One*, **9**(1), e83783. http://doi.org/10.1371/journal.pone.0083783

Jones G. Stathokostas L., Young B., Wister A., Chau S., Clark P., Duggan M., Mitchell D., & Nordland P. (2018). Development of a physical literacy model for older adults – A consensus process by the collaborative working group on physical literacy for older Canadians. *Biomedical Central (BMC) Geriatrics*. **18**, 13. http://doi.org/10.1186/s12877-017-0687-x

Kendig, H., Browning, C., Thomas, S., & Wells, Y. (2014). Health, lifestyle and gender influences on aging well: An Australian longitudinal analysis to guide health promotion. *Frontiers in Public Health*, **2**, 70. http://doi.org/10.3389/fpubh.2014.00070

Kirchberger, I., Meisinger, C., Heier, M., Zimmermann, A. K., Thorand, B., Autenrieth, C. S., *et al.* (2012). Patterns of multimorbidity in the aged population. Results from the KORA-Age study. *PLoS One*, **7**, e30556.

https://doi.org/10.1017/S0714980821000544 Published online by Cambridge University Press

Kirkland, S., Griffith, L., Menec, V., Wister, A., Hélène, P., Wolfson, C., *et al.* (2015). Mining a unique Canadian resource: The Canadian longitudinal study on aging. *Canadian Journal on Aging*, **34**(3), 366–377. http://doi.org/10.1017/S071498081500029X

Klasa, K., Galaitsi, S., Wister, A., & Linkov, I. (2021). System models for resilience in gerontology: Application to the COVID-19 pandemic. *BMC Geriatrics*, **21**, 51. https://doi.org/10.1186/s12877-020-01965-2

Linkov, I., & Kott, A. (2019). Fundamental concepts of cyber resilience: Introduction and overview. In *Cyber resilience of systems and networks* (pp. 1–25). New York: Springer.

McGinnis, J., Williams-Russo, P., & Knickman, J. (2002). The case for more active policy attention to health promotion. *Health Affairs (Millwood)*, **21**, 78–93.

Netuveli, G., & Blane, D. (2008). Quality of life in older ages. *British Medical Bulletin*, **85**, 113–126.

Ng, S. K., Holden, L., & Sun, J. (2012). Identifying comorbidity patterns of health conditions via cluster analysis of pairwise concordance statistics. *Statistics in Medicine*, **31**, 3393–3405. http://doi.org/10.1002/sim.5426

Ong, A. D., Bergeman, C. S., Bisconti, T. L., & Wallace, K. (2006). Psychological resilience, positive emotions, and successful adaptation to stress in later life. *Journal of Personality and Social Psychology*, **91**, 730–749.

Ong, A. D., Zautra, A. J., & Reid, M. C. (2010). Psychological resilience predicts decreases in pain catastrophizing through positive emotions. *Psychology and Aging*, **25**, 516–523.

Ong, A. D., Zautra, A. J., & Reid, M. C. (2015). Chronic pain and the adaptive significance of positive emotions. *American Psychologist*, **70**, 283–284.

Peters, S., Cosco, T., Mackey, D., Sarohia, G., Leong, J., & Wister, A. (2019). Methods for quantifying physical resilience in aging: A scoping systematic review protocol. *Systematic Reviews*, **8**, 34–40. http://doi.org/10.1186/s13643-019-0950-7

Prados-Torres, A., Poblador-Plou, B., Calderón-Larrañaga, A., Gimeno-Feliu, L. A., González-Rubio, F., Poncel-Falcó, A., *et al.* (2012). Multimorbidity patterns in primary care: Interactions among chronic diseases using factor analysis. *PLoS One*, **7**, e32190.

Pruchno, R., & Carr, D. (2017). Successful aging 2.0: Resilience and beyond. *Journals of Gerontology: Series B*, **72**(2), 201–203. http://doi.org/10.1093/geronb/gbw214

Pruchno, R., & Wilson-Genderson, M. (2012). Adherence to clusters of health behaviors and successful aging. *Journal of Aging and Health*, **24**(8), 1279–1297. https://doi.org/10.1177/0898264312457412

Prus, S. (2011). Comparing social determinants of self-rated health across the United States and Canada. *Social Science & Medicine (1982)*, **73**(1), 50–59.

Quiñones, A. R., Liang, J., Bennett, J. M., Xu, X., & Ye, W. (2011). How does the trajectory of multimorbidity vary across Black, White, and Mexican Americans in middle and old age? *Journal of Gerontology*, **66**, 739–749. http://doi.org/10.1093/geronb/gbr106

Raphael, D. (Ed.) (2016). *Social Determinants of Health: Canadian Perspectives*. 3rd edition. Toronto, ON:Canadian Scholars' Press Inc.

Raina, P.S., Wolfson, C., Kirkland, S.A., Griffith, L.E., Balion, C., Cossette, B., *et al.* 2019). Cohort Profile: The Canadian Longitudinal Study on Aging (CLSA), *International Journal of Epidemiology*, **48** (6), 1752–1753. http://doi.org/10.1093/ije/dyz173

Raina, P. S., Wolfson, C., Kirkland, S. A., Griffith, L. E., Oremus, M., Patterson, C., *et al.* (2009). The Canadian Longitudinal Study on Aging (CLSA). *Canadian Journal on Aging /La Revue Canadienne du Vieillissement*, **28** (3), 221–229. http://doi.org/10.1017/S0714980809990055

Resnick, B., Gwyther, L., Roberto, K. (Eds.) (2019). *Resilience and Aging: Concepts, Research and Outcomes*, 2nd Edition. New York: Springer.

Richardson, G. (2002) The metatheory of resilience and resiliency. *Journal of Clinical Psychology*, **58**, 307–321.

Rootman, I., Pederson, A., Frohlich, K., & Dupéré, S. (Eds.) (2012). *Health promotion in Canada: Critical perspectives on practice*. Toronto: Canadian Scholars' Press.

Rybarczyk, B., Emery, E., Guequierre, L., Shamaskin, A. & Behel, J. (2012). The role of resilience in chronic illness and disability in older adults. In B. Hayslip & G. Smith (Eds.), *Annual review of gerontology and geriatrics*, *2012 special issue: Emerging perspectives on resilience in adulthood and later life* (vol. 32) (pp. 173–188). New York: Springer.

Salive, M. (2013). Multimorbidity in older adults. *Epidemiologic Reviews*, **35**, 75–83. http://doi.org/10.1093/epirev/mxs009

Schafer, I., von Leitner, E.-C., Schön, G., Koller, D., Hansen, H., Kolonko, T., *et al.* (2010). Multimorbidity patterns in the elderly: A new approach of disease clustering identifies complex interrelations between chronic conditions. *PLoS One*, **5**(12), e15941.

Sells, D., Sledge, W. H., Wieland, M., Walden, D., Flanagan, E., Miller, R., *et al.* (2009). Cascading crises, resilience, and social support within the onset and development of multiple chronic conditions. *Chronic Illness*, **5**(2), 92–102. http://doi.org/10.1177/1742395309104166

Sharkey, J. (2003). Risk and presence of food insufficiency are associated with low nutrient intakes and multimorbidity among homebound older women who receive home-delivered meals. *The Journal of Nutrition*, **133**(11), 3485–3491.

Short, S., & Mollborn, S. (2015). Social determinants of health behaviors: Conceptual frames and empirical advances. *Current Opinion in Psychology*, **5**, 78–84.

Silverman, A., Molton, I., Alschuler, K., Ehde, D., & Jensen, M. (2015). Resilience predicts functional outcomes in people aging with disabilities: A longitudinal investigation. *Archives of Physical Medicine and Rehabilitation*, **96**, 1262–1268.

Skivington, K., Katikireddi, S., Leyland, A., Hunt, K., & Mercer, S. (2015). Risk factors for multimorbidity: A multilevel analysis of a longitudinal cohort from Scotland. *European Journal of Public Health*, **25**(Suppl._3), ckv167.020. http://doi.org/10.1093/eurpub/ckv167.020

Smith, K. W. (1991). *PASE journal of gerontology administration and scoring instruction manual*. Watertown, MA: New England Research Institutes.

Stewart, D., & Yuen, T. (2011). A systematic review of resilience in the physically ill. *Psychosomatics*, **52**(3), 199–209.

Trivedi, R., Bosworth, H., & Jackson, G. (2011). Resilience in chronic illness. In B. Resnick, L. Gwyther, & K. Roberto (Eds.), *Resilience in aging: Concepts, research and outcomes* (pp. 45–63). New York: Springer.

Ungar, M. (2011). The social ecology of resilience: Addressing contextual and cultural ambiguity of a nascent construct. *American Journal of Orthopsychiatry*, **81**(1), 1–17.

Verbrugge, L., & Jette, A. (1994) The disablement process. *Social Science and Medicine*, **38**, 1–14.

Whitson, H., Johnson, K. S., Sloane, R., Cigolle, C. T., Pieper, C. F., Landerman, L., *et al.* (2016). Identifying patterns of multimorbidity in older Americans: Applications of latent class analysis. *American Geriatrics Society*, **64**, 1668–1673.

Wiles, J., Wild, K., Kerse, N., & Allen, R. (2012). Resilience from the point of view of older people: 'There's still life beyond the funny knee'. *Social Science and Medicine*, **74**, 416–424.

Windle, G. (2011). What is resilience? A review and concept analysis. *Reviews in Clinical Gerontology*, **21**(2), 152–169. http://doi.org/10.1017/S0959259810000420

Windle, G. (2012). The contribution of resilience to healthy ageing. *Perspectives in Public Health*, **132**(4), 159–160. http://doi.org/10.1177/1757913912449572

Windle, G., Woods, R., & Markland, D. (2010). Living with ill-health in old age: The role of a resilient personality. *Journal of Happiness Studies*, **11**, 763–777.

Wister, A. (2005). *Baby boomer health dynamics: How are we aging?* Toronto: University of Toronto Press.

Wister, A. (2019). *Aging as a Social Process: Canada and Beyond*, 7th Edition. Don Mills ON: Oxford University Press

Wister, A., Coatta, K., Schuurman, N., Lear, S., Rosin, M., & MacKey, D. (2016). A lifecourse model of resilience applied to aging with multimorbidity. *International Journal of Aging & Human Development*, **82**, 290–313. http://doi.org/10.1177/0091415016641686

Wister, A., Cosco, T., Mitchell, B., & Fyffe, I. (2020). Health behaviors and multimorbidity resilience among older adults using the Canadian Longitudinal study on aging. *International Psychogeriatrics*, **32**, 119–133. http://doi.org/10.1017/S1041610219000486

Wister, A., Cosco, T., Mitchell, B., Menec, V., & Fyffe, I. (2019). Development and concurrent validity of a composite social isolation index for older adults using the Canadian longitudinal study on aging. *Canadian Journal on Aging*, **38**(2), 180–192. http://doi.org/10.1017/S0714980818000612

Wister, A., Kendig, H., Mitchell, B. A., Fyffe, I., & Loh, V. (2016). Multimorbidity, health and aging in Canada and Australia: A tale of two countries. *Biomedical Central Geriatrics*, **16**(1), 163. http://doi.org/10.1186/s12877-016-0341-z

Wister, A., Lear, S., Schuurman, N., MacKey, D., Mitchell, B., Cosco, T., *et al.* (2018). Development and validation of a multi-domain multimorbidity resilience index for an older population: Results from the baseline Canadian Longitudinal study on aging. *Biomedical Central (BMC) Geriatrics*, **18**, 170. http://doi.org/10.1186/s12877-018-0851-y

Wister, A., Levasseur, M., Griffiths, L., & Fyffe, I. (2015). Estimating multiple morbidity disease burden among older persons: A convergent construct validity study to discriminate between six chronic illness measures, CCHS 2008/09. *Biomedical Central Geriatrics*, **15**, 12. http://doi.org/10.1186/s12877-015-0001-8

Wister, A., Rosenkrantz, L., Shashank, A., Walker, B., & Schuurman, N. (2020). Multimorbidity and socioeconomic deprivation among older adults: A cross-sectional analysis in five Canadian Cities using the CLSA. *Environment and Aging*, **34**, 435–454. http://doi.org/10.1080/26892618.2020.1734138

Wister, A., & Speechley, M. (2020). COVID-19: Pandemic risk, resilience and possibilities for aging research. *Canadian Journal on Aging*, **39**(3), 344–347.

Wister, A. V., & Cosco, T. (Eds.) (2021). *Resilience and aging: Emerging science and future possibilities*. New York: Springer.

Zautra, A., Arewasikporn, A., & Davis, M. (2010). Resilience: Promoting well-being through recovery, sustainability, and growth. *Research in Human Development*, **7**(3), 221–238. http://doi.org/10.1080/15427609.2010.504431

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