The Role of Social Participation and Walking in Depression among Older Adults: Results from the VoisiNuAge Study*

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RÉSUMÉ

Des niveaux moins élevés de participation sociale et d'épisodes de marche représentent deux facteurs pouvant contribuer à la dépression chez les personnes âgées, mais les recherches antérieures ne sont pas concluantes à ce sujet. L'objectif de cette étude transversale est de quantifier les associations entre la dépression et l'effet combiné de la participation sociale et de la marche dans un échantillon de personnes âgées vivant au Canada (n = 549). Des analyses de régressions linéaires et logistiques ont été effectuées pour examiner si la participation sociale et la marche prédisent la dépression indépendamment des caractéristiques individuelles. Dans les modèles finaux, les résultats suggèrent que les individus qui ne prennent pas de marches présentent davantage de symptômes dépressifs ou une possible dépression (l'association entre la participation sociale et la dépression devient non significative dans les modèles ajustés). La présente étude souligne le rôle central des habitudes de vie telle la marche pour la santé mentale des aînés.

ABSTRACT

Lower social participation and less frequent walking represent two factors that may contribute to depression among older adults, but previous research on the subject is inconclusive. The aim of this cross-sectional study was to quantify associations between depression and the combined effects from social participation and walking in a sample of older adults living in Canada (n = 549). Linear and logistic regression analyses were conducted, in which we entered social participation and walking as predictors of depression while controlling for individual characteristics. Results of the final models show that individuals who do not walk outside their home report more depressive symptoms or a greater likelihood of possible clinical depression (the association in our study between social participation and depression was attenuated to non-significance). The current study highlights the central role played by life habits, such as walking, in older adults' mental health status.

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Depression is the most common mental health problem among older adults (Buchanan et al., 2006) and is not a normal part of aging (Fiske, Wetherell, & Gatz, 2009). It is associated with increased risks of suicide and decreased physical, cognitive, and social functioning (Blazer, 2003). In Canada, approximately 500,000 older adults live with substantial depressive symptoms or clinical depression (Buchanan et al., 2006). The advent of global population aging has highlighted the importance of identifying factors that may contribute to the extent of depressive symptoms or clinical depression among elderly people (Reid & Planas, 2002). One symptom of clinical depression is loss of interest or pleasure in activities that were previously considered pleasurable (American Psychiatric Association, 1994), such as social or physical activities. A decrease in activity level may deprive individuals of pleasure and sense of mastery, thereby precipitating or maintaining the extent of depressive symptoms or clinical depression (Dimidjian, Martell, Addis, & Herman-Dunn, 2008).

Social participation and physical activity are two factors that may contribute to the extent of depressive symptoms or possible clinical depression. Social participation can be defined as "a person's involvement in activities providing interaction with others in society or the community" (Levasseur, Richard, Gauvin, & Raymond, 2010). Social participation may protect against the extent of depressive symptoms or possible clinical depression in three ways: (a) by stimulating bodily systems such as cardiovascular or cognitive system, (b) by helping a person to cope with difficulties, and (c) by reinforcing an individual's attachment to other psychosocial resources such as social support (Glass, De Leon, Bassuk, & Berkman, 2006). Although studies suggest that greater social participation is associated with the lessening of either depressive symptoms or possible clinical depression among older adults (Carvalhais et al., 2008; Glass et al., 2006; Isaac, Stewart, Artero, Ancelin, & Ritchie, 2009; Rozzini, Boffelli, Franzoni, Frisoni, & Trarucchi, 1996; Zunzunegui, Béland, Llácer, & León, 1998), some issues may restrict the interpretation of results. For example, the number of items measuring social participation is sometimes limited to two (e.g., Carvalhais et al., 2008) or three (e.g., Zunzunegui et al., 1998) items, such as going out to the plaza or social center. Moreover, Glass et al. (2006) underscored that questionnaires may not have been specific to social participation (i.e., they sometimes include other social dimensions such as social support), and called for replication of results with other questionnaires measuring social participation.

Physical activity has been associated with better physical health, but its association with the extent of depressive symptoms or possible clinical depression among older adults is less clear (Cairney, Faught, Hay, Wade, & Corna, 2005). Physical activity is thought to prevent or lessen the extent of depressive symptoms or possible clinical depression by activating selected biological pathways, increasing a sense of mastery, a sense of self-worth, or number of social contacts, or by distracting from negative thoughts (Lawlor & Hopker, 2001). Walking may be the most practical form of physical activity, but surprisingly, few studies have focused on walking as a predictor of the extent of depressive symptoms or possible clinical depression among older adults, and study results have been inconsistent. For example, greater number of steps taken per day was related to lower levels of depressive symptoms (Yoshiuchi et al., 2006). In contrast, baseline walking habits were not associated with baseline depressive symptoms or possible clinical depression (Simonsick, Guralnik, & Fried, 1999), nor with the future extent of these conditions (Morgan, & Bath, 1998; Perrino, Mason, Brown, & Szapocznik, 2010) after controlling for co-variates in the final models; however, the extent of depressive symptoms at baseline was found to be related to poorer future walking habits (Perrino et al., 2010).

Other studies outlined patterns of associations between walking and potential clinical depression that differed according to the number of chronic illnesses (Smith et al., 2010) or initial level of depressive symptoms (Mobily, Rubenstein, Lemke, & Wallace, 1996). Additional research is thus needed to clarify associations between walking and the extent of depressive symptoms or the presence of a possible clinical depression.

Moreover, the majority of studies have investigated depressive mood either on a continuum (i.e., extent of depressive symptoms on a scale) or as a possible diagnostic category (clinically depressed vs. non-depressed), but these outcome measures have rarely

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been investigated simultaneously. The continuum approach relies on a population health paradigm whereas the diagnosis approach is based on a clinical model. Although it is important to understand the characteristics of depressed individuals in need of clinical interventions, it is also imperative to understand what is associated with the extent of subclinical depressive symptoms because subclinical depression is (a) detrimental to a health-related quality of life, (b) linked to greater use of health care services, and (c) likely a precursor to the development of clinical depression requiring psychotherapeutic or pharmacological treatment (Lebowitz et al., 1997).

The aim of this study was to quantify associations among community-dwelling older adults between depression (measured as a continuous variable and as a dichotomous variable) and the combined effects from social participation and walking (adjusting for demographic characteristics, socio-economic characteristics, physical health variables, and physical activity other than walking). Clarifying associations between social participation and walking in relation to depression among older adults may be of interest for professionals in different domains. For example, health promotion professionals may find in this study potential protective factors against depression which could eventually be intervention targets; clinical psychologists and physicians may find targets of interventions for their patients; and urban policy makers may be interested in developing environments to foster factors that promote good mental health.

Methods

Design, Participants, and Procedure

The research design involved a cross-sectional analysis of a five-year longitudinal study. With the exception of age and education which were collected at baseline, the data used in the current study were collected at year three because this wave of data collection included the most detailed information regarding the variables of interest. The study was cast within a larger investigation called "VoisiNuAge", which examined the relationships between neighborhood environments and health-related behaviors among seniors. The VoisiNuAge study integrates existing data from two sources: (a) the NuAge study, a five-year observational study on nutrition and successful aging (Gaudreau et al., 2007; Payette et al., 2011); and (b) MEGAPHONE (Montreal Epidemiological and Geographical Analysis of Population Health Outcomes and Neighborhood Effects), a geographic information system for health research (Daniel & Kestens, 2007) that uses the GeoPinpoint software (DMTI Spatial Inc., Markham, Canada) and online mapping tools with satellite images, thereby allowing for geocoding of participants at the address level.

NuAge respondents (n = 1,793) were recruited in 2003 from an age- and sex-stratified random sample drawn from the Québec Medicare database for the Montreal, Laval, and Sherbrooke regions in the province of Quebec, Canada. All residents of the province were included in the database because of universal health care coverage in Quebec. Inclusion criteria were as follows: (a) aged 68 to 84; (b) in good health at inception; (c) French- or English-speaking; (d) free of disabilities in activities of daily living; (e) without cognitive impairment; (f) able to walk one block or climb one-floor flight of stairs without rest; (g) absence of heart failure (≥ class II), chronic obstructive pulmonary disease requiring oxygen therapy or oral steroids, inflammatory digestive diseases or cancer treated either by radiation therapy, chemotherapy, or surgery in the past five years; and (h) willingness to commit to a five-year study. The participation rate (sample studied/total eligible subjects) was 58.6%. Participants were followed annually and underwent a series of nutritional, functional, medical, biological, and social measurements in four annual follow-ups. Computer-assisted interviews were carried out by trained research dieticians and nurses following standardized procedures (Payette et al., 2011).

For the VoisiNuAge study, participants were those who resided in the Montreal metropolitan area (n = 848). We further limited the sample to those who were still in the cohort at year three of the follow-up for the current investigation (n = 681), excluding drop-outs (n = 88), persons who moved between measurement times (n = 68), and deceased participants (n = 11). The number of respondents having complete data on variables for this study was 549. Participants signed an informed consent form, and the research was approved by the ethics committees of the University Geriatrics Institutes in Montreal and Sherbrooke (ethical approval numbers 2007-1101A and 2008/14).

Measures

Depression

The extent of depressive symptoms and possible clinical depression were assessed using the Geriatric Depression Scale (GDS; Yesavage et al., 1983), a 30-item questionnaire with a yes/no response format. Higher scores on the GDS indicate higher levels of depressive symptoms. Participants with a GDS score ≥ 11 were categorized as being potentially clinically depressed (Brink et al., 1982). In the current sample, the GDS scale had a Cronbach's alpha of 0.83.

Socio-demographic and Health Characteristics

Socio-demographic characteristics were assessed by a series of items on sex, age, marital status (married/common law, single, divorce/separated, and widowed),

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education (2–11, 12–13, and 14+ years), annual family income (recoded as below or over the Statistics Canada [2004] low-income cut-off), and country of birth (Canada, elsewhere). Recent stressful events (yes, no) were assessed by a single question taken from the Elderly Nutrition Screening questionnaire (Payette, 2003) which read as follows: "Have you recently suffered a stressful life event (e.g., personal illness/death of a loved one)?". The number of chronic illnesses was evaluated with a list of 23 medical conditions (see Table 1), and responses were recoded into approximate tertiles (< 2, 2–4, and 5+ chronic illnesses).

Social Participation

Social participation was investigated using a 10-item scale adapted from the social portion of the Elderly Activity Inventory Questionnaire (Lefrançois, Leclerc, Dubé, Hamel, & Gaulin, 2001) and Statistics Canada's Participation and Activity Limitation Survey (www.statcan.ca/english/sdds/instrument/3251_Q2_V1_E.pdf). The scale allowed us to evaluate respondents' involvement in the following social activities: (a) visiting family members/friends, (b) engaging in hobby outside the home, (c) attending activities at a community/leisure centre, (d) go shopping, (e) go to a restaurant/pub/café, (f) attending sports or cultural events, (g) taking lessons or courses, (h) participating in self-help or discussion groups, (i) going to a public library or a cultural centre, and (j) doing some volunteer work. Response options were "almost every day", "at least once a week", "at least once a month", less than once a month", and "never". Categories were converted into number of days per month ("almost every day": 20 days; "at least once a week": 6 days; "at least once a month": 2 days; "less than once a month": 1 day; and "never": 0 days). Internal consistency of the scale, established through application of principles of item response theory, was 0.85 (Richard et al., 2013). The number of days per month ascribed to each activity was summed, and participants' scores were re-recategorized into quintiles representing a continuum from lowest level of social participation (1st quintile) to highest level of social participation (5th quintile).

Walking and Physical Activity

The Physical Activity Scale for the Elderly (PASE) (Washburn, Smith, Jette, & Janney, 1993) was used to assess walking and physical activity other than walking. The test-retest reliability of the PASE is good ($r = 0.75$), and convergent validity with health, strength, and balance is deemed satisfactory (Washburn et al., 1993). In the current study, walking was assessed by singling out one question from the PASE relating to the frequency of walking. The question read: "Over the past 7 days, how often did you walk outside your home or yard for any reason? For example, for fun or exercise, walking

Table 1: Respondent characteristics (*n* = 549)

Characteristics	*n* (%)	Mean (*SD*)
Age		74.76 (4.11)
Sex		
Male	256 (46.6)	
Female	293 (53.4)	
Marital status		
Married/common law	294 (53.6)	
Single	58 (10.6)	
Divorced/separated	43 (7.8)	
Widowed	154 (28.1)	
Education (in years)		
2–11	225 (41.0)	
12, 13	101 (18.4)	
14+	223 (40.6)	
Income		
≤ low-income cut-off[a]	60 (10.9)	
> low-income cut-off	489 (89.1)	
Born in Canada		
Yes	445 (81.1)	
No	104 (18.9)	
Extent of depressive symptoms (GDS score)		4.93 (4.36)
Possible clinical depression (GDS ≥ 11)		
Yes	68 (12.4)	
No	481 (87.6)	
Stressful events		
Yes	189 (34.4)	
No	360 (65.6)	
Number of chronic illnesses[b]		
0–1	95 (17.3)	
2–4	294 (53.6)	
5+	160 (29.1)	
Physical activity other than walking		74.06 (43.60)
Social participation		
1st quintile	116 (21.1)	
2nd quintile	109 (19.9)	
3rd quintile	108 (19.7)	
4th quintile	110 (20.0)	
5th quintile	106 (19.3)	
Frequency of walking		
Never (0 days)	116 (21.1)	
Seldom (1–2 days)	97 (17.7)	
Sometimes (3–4 days)	103 (18.8)	
Often (5–7 days)	233 (42.4)	

***GDS* = Geriatric Depression Scale**
***SD* = standard deviation**
[a] Defined as living alone and annual income ≤ $19,795 or living with a spouse but annual household income ≤ $24,745
[b] arthritis/rheumatism, glaucoma/ocular disease, oedema, asthma, emphysema/chronic bronchitis, high blood pressure, heart trouble, circulatory problems in arms or legs, diabetes, ulcers (of the digestive systems), other digestive problems (vomiting, constipation, diverticulosis), liver or gallbladder disease, kidney disease, urinary problems (prostate), osteoporosis, cancer, anaemia, thrombosis/cerebral haemorrhage/CVA, Parkinson's disease, thyroid and gland problems, skin disorders, epilepsy, other diseases (specified)

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to work, walking the dog, etc.?". The response options were as follows: never (0 days), seldom (1–2 days), sometimes (3–4 days), and often (5–7 days).

Although the PASE also assesses duration of walking, we focused on frequency of walking because response options for duration were too broad within the context of a population survey for older adults (the smallest duration category was less than 1 hour per day). There are no validity data on the question used for walking. However, the item has face validity, as it shares considerable resemblance with a validated question from the International Physical Activity Questionnaire (Craig et al., 2003). Moreover, the measure is associated with known built environment determinants (Gauvin et al., 2012), thus suggesting construct validity. Because physical activity may be an important confounding variable, a subscale for physical activity other than walking was created by removing the walking score (frequency and duration) from the PASE total score. The physical-activity-other-than-walking score pertains to light, moderate, or strenuous sports, muscle strength/endurance, light or heavy household chores, home repairs, and the like. Higher scores on this modified PASE scale mean greater physical activity levels.

Statistical Analysis Strategy

Group differences between VoisiNuAge participants still in the cohort at year three of follow-up and those that were lost (due to dropping out, moving, or death) were investigated, using analyses of variance or chi-square analyses on (a) social participation, (b) walking, (c) the extent of depressive symptoms, (d) possible clinical depression, (e) age, (f) sex, (g) marital status, (h) education, (i) income, (j) country of birth, (k) stressful events, (l) number of chronic illnesses, and (m) physical activity other than walking. Group differences between participants included in the analyses and those excluded because of missing data were also explored. Baseline or year-three follow-up scores were used according to which was most relevant for the analyses. Descriptive analyses were performed to characterize participants included in the final sample. Kendall's tau correlation for ordinal variables was computed to examine the relationship between social participation and walking. Finally, linear regression analyses predicting the extent of depressive symptoms and logistic regression analyses predicting possible clinical depression were performed. Social participation and walking were treated as the main exposure variables. We built the following incremental regression models: main exposures tested separately (Models 1a and 1b); main exposures tested simultaneously (Model 2); main exposures tested simultaneously but successively adjusting for blocks of variables starting with demographic and socioeconomic characteristics (Model 3), followed by stressful events and chronic illnesses (Model 4), and by physical activity other than walking (Model 5). We also tested interactions between social participation and walking. The analyses were carried out with PASW statistical software (version 18).

Results

Participant Characteristics

We compared VoisiNuAge participants who dropped out ($n = 88$), migrated to another dwelling ($n = 68$), or died ($n = 11$) with other VoisiNuAge participants ($n = 681$). We found that those born in Canada and those who reported five or more chronic illnesses were more likely to have moved between measurement times ($p < .01$). Those dropping out were more likely to be widowed at baseline ($p < .05$), to report low income ($p < .01$), and to be born outside Canada ($p < .01$). Those dying were more likely to be born outside Canada ($p < .05$) or to report low income ($p < .01$). In addition, those dying showed a non-significant tendency to be older and those moving showed a trend towards higher depression scores ($p < .10$). Among the remaining participants ($n = 681$), those who were excluded from the analyses because of incomplete data ($n = 132$) were significantly older than those who were included in the analyses ($n = 549$) ($p < .001$), more often born outside Canada ($p < .001$), reported experiencing more stressful events ($p < .01$), and showed a slightly different profile of social participation (that is, they were less often in the second quintile of social participation; $p < .05$).

The characteristics of respondents appear in Table 1. The mean age of participants at cohort inception was 74.76 years (range: 68–84). There were approximately as many male as female participants, and similar proportions of people living with and without a partner. The vast majority of the sample was born in Canada and had an income over the low-income cut-off. The mean score on the GDS (extent of depressive symptoms) was 4.93 (range: 0–24), and 12.4 per cent of respondents had scores above the cut-off for being possibly clinically depressed. About one-third of participants reported recent stressful life events, and most (83%) reported more than one chronic illness. Forty-two per cent of the sample reported walking often. The correlation between social participation and walking was statistically significant but small (Kendall's tau = .15, $p < .001$).

Linear Regression Analyses

A square root transformation was applied to GDS scores to normalize the distribution. Table 2 shows the results of linear regression analyses. In bivariate analyses, social participation (Model 1a) and walking (Model 1b) were both significantly associated with the

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Table 2: Associations between social participation, walking, and other co-variates with the extent of depression symptoms estimated through linear regression analyses (square root of GDS score) amongst adults aged 68 years and older from the VoisiNuAge Study ($n = 549$)

Characteristics	Model 1a		Model 1b		Model 2		Model 3		Model 4		Model 5	
	B (*SE*)	*β*	B (*SE*)	*β*	B (*SE*)	*β*	B (*SE*)	*β*	B (*SE*)	*β*	B (*SE*)	*β*
Intercept	1.84*** (0.10)		1.81*** (0.07)		1.73*** (0.11)		–0.14 (0.81)		0.22 (0.77)		1.15 (0.81)	
Social participation												
1st quintile (lowest)	0.38** (0.14)	.15			0.31* (0.14)	.13	0.33* (0.14)	.13	0.25† (0.13)	.10	0.21 (0.13)	.08
2nd quintile	0.23† (0.14)	.09			0.17 (0.14)	.07	0.20 (0.14)	.08	0.18 (0.13)	.07	0.17 (0.13)	.07
3rd quintile	0.18 (0.14)	.07			0.14 (0.14)	.06	0.15 (0.14)	.06	0.11 (0.13)	.04	0.09 (0.13)	.03
4th quintile	–0.14 (0.14)	–.05			–0.15 (0.14)	–.06	–0.11 (0.14)	–.05	–0.12 (0.13)	–.05	–0.13 (0.13)	–.05
5th quintile (highest) (ref.)	–	–			–	–	–	–	–	–	–	–
Frequency of walking												
Never (0 days)			0.43*** (0.12)	.17	0.35** (0.12)	.14	0.34** (0.12)	.14	0.27* (0.11)	.11	0.29* (0.11)	.12
Seldom (1–2 days)			0.25* (0.12)	.09	0.24† (0.12)	.09	0.25* (0.12)	.09	0.20† (0.12)	.07	0.20† (0.12)	.07
Sometimes (3–4 days)			0.16 (0.12)	.06	0.14 (0.12)	.06	0.15 (0.12)	.06	0.17 (0.11)	.07	0.17 (0.11)	.07
Often (5–7 days) (ref.)			–	–	–	–	–	–	–	–	–	–
Age							0.02* (0.01)	.09	0.01 (0.01)	.05	0.00 (0.01)	.01
Sex												
Female							0.15 (0.10)	.07	0.01 (0.09)	.00	–0.05 (0.09)	–.02
Male (ref.)							–	–	–	–	–	–
Marital status												
Single							–0.02 (0.16)	–.01	0.03 (0.15)	.01	0.00 (0.15)	.00
Divorced							0.17 (0.17)	.04	0.14 (0.16)	.04	0.12 (0.16)	.03
Widowed							0.06 (0.11)	.03	0.09 (0.11)	.04	0.10 (0.10)	.04
Married (ref.)							–	–	–	–	–	–
Education (in years)												
2–11 years							0.03 (0.10)	.01	0.10 (0.09)	.05	0.11 (0.09)	.05
12–13 years							0.10 (0.12)	.04	0.17 (0.12)	.07	0.15 (0.12)	.06
14+ (ref.)							–	–	–	–	–	–
Income												
≤ low-income cut-off							–0.05 (0.14)	–.01	–0.10 (0.14)	–.03	–0.10 (0.13)	–.03
> low-income cut-off (ref.)							–	–	–	–	–	–
Country of birth												
Canada (ref.)							–	–	–	–	–	–
Born outside Canada							0.33** (0.11)	.13	0.30** (0.11)	.11	0.29** (0.10)	.11
Stressful events												
Yes									0.54*** (0.09)	.25	0.55*** (0.09)	.26
No (ref.)									–	–	–	–
Chronic illnesses												
0,1 (ref.)									–	–	–	–
2–4									0.22† (0.12)	.11	0.20† (0.11)	.10
5+									0.62*** (0.13)	.28	0.57*** (0.13)	.25

Continued

Table 2. Continued

Characteristics	Model 1a		Model 1b		Model 2		Model 3		Model 4		Model 5	
	B (*SE*)	β	B (*SE*)	β	B (*SE*)	β	B (*SE*)	β	B (*SE*)	β	B (*SE*)	β
Physical activity other than walking											0.00** (0.00)	–.14
Adjusted R^2	.03		.02		.04		.05		.16		.18	

SE **= standard error**
Model 1a: Social participation tested separately
Model 1b: Walking tested separately
Model 2: Social participation and walking tested simultaneously
Model 3: Model 2 with control for demographic and socioeconomic characteristics (age, sex, marital status, education, income, and country of birth)
Model 4: Model 3 with control for recent stressful events and number of chronic illnesses
Model 5: Model 4 with control for physical activity other than walking
† < .10, *p < .05, **p < .01, ***p < .001

extent of depressive symptoms: participants in the lowest quintile of social participation reported higher depression scores than participants in the highest quintile of social participation (β = .15, p < .01), and participants who did not walk or who walked rarely outside their home reported higher depression scores than participants who walked often outside their home (βs = .17 and .09, ps < .001 and .05 respectively). When tested simultaneously (Model 2), social participation and walking were both statistically associated with the extent of depressive symptoms: participants in the lowest quintile of social participation and respondents who did not walk outside their home reported higher depression scores (βs = .13 and .14, ps < .05 and .01 respectively). This finding was true even when we adjusted for demographic and socioeconomic variables (Model 3; βs = .13 and .14, ps < .05 and .01 respectively). This association remained statistically significant for walking when further adjusted for stressful events and number of chronic illnesses (Model 4; β = .11, p < .05), but the association between social participation and the extent of depressive symptoms became non-significant, although participants in the lowest quintile of social participation showed a trend towards higher depression scores than participants in the highest quintile of social participation (β = .10, p < .10). Finally, the association between walking and the extent of depressive symptoms remained statistically significant when we further controlled for physical activity other than walking (Model 5; β = .12, p < .05).

In addition to walking, being born outside Canada (β = .11, p < .01), the occurrence of stressful events (β = .26, p < .001), and reporting five or more chronic illnesses (β = .25, p < .001) were associated with higher depressive symptoms in the final model (Model 5), whereas greater physical activity level was associated with lower depression scores (β = –.14, p < .01); the final model achieved an adjusted R^2 of .18. No significant interactions between social participation and walking were identified (models not reported).

Logistic Regression Analyses

When social participation and walking were tested separately (see Table 3; Models 1a and 1b respectively), associations were observed between main exposures and possible clinical depression: participants in the lowest quintile of social participation reported a greater likelihood of being potentially clinically depressed in comparison to participants in the highest quintile of social participation (OR = 2.52, 95% CI: 1.11, 5.76), and participants who did not walk outside their home reported greater likelihood of being potentially clinically depressed than participants who walked outside the home often (OR = 3.25, 95% CI: 1.71, 6.18). When social participation and walking were tested simultaneously

Table 3: Associations between social participation, walking, and other co-variates with possible clinical depression estimated through logistic regression analyses among adults aged 68 years and older from the VoisiNuAge Study (*n* = 549)

Characteristics	Model 1a OR (95% CI)	Model 1b OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Intercept	0.09***	0.09***	0.07***	0.01†	0.01	0.03
Social participation						
1st quintile (lowest)	2.52* (1.11, 5.76)		2.04† (0.88, 4.74)	2.27† (0.95, 5.41)	2.09 (0.85, 5.13)	2.02 (0.82, 5.00)
2nd quintile	1.72 (0.72, 4.12)		1.44 (0.59, 3.50)	1.57 (0.63, 3.91)	1.50 (0.58, 3.89)	1.47 (0.57, 3.82)
3rd quintile	1.48 (0.60, 3.61)		1.34 (0.54, 3.32)	1.43 (0.57, 3.60)	1.38 (0.53, 3.58)	1.35 (0.52, 3.52)
4th quintile	0.96 (0.37, 2.52)		0.94 (0.36, 2.49)	0.98 (0.36, 2.62)	1.05 (0.38, 2.92)	1.04 (0.38, 2.88)
5th quintile (highest) (ref.)	1.00		1.00	1.00	1.00	1.00
Frequency of walking						
Never (0 days)		3.25*** (1.71, 6.18)	2.85** (1.48, 5.48)	2.85** (1.43, 5.68)	2.56* (1.25, 5.25)	2.57* (1.25, 5.28)
Seldom (1–2 days)		1.74 (0.82, 3.69)	1.70 (0.80, 3.61)	1.76 (0.80, 3.85)	1.48 (0.65, 3.53)	1.46 (0.64, 3.32)
Sometimes (3–4 days)		1.21 (0.54, 2.71)	1.19 (0.53, 2.67)	1.16 (0.51, 2.64)	1.23 (0.52, 2.93)	1.22 (0.52, 2.91)
Often (5–7 days) (ref.)		1.00	1.00	1.00	1.00	1.00
Age				1.02 (0.96, 1.10)	0.99 (0.92, 1.07)	0.99 (0.92, 1.06)
Sex						
Female				1.54 (0.85, 2.80)	1.13 (0.61, 2.10)	1.09 (0.58, 2.05)
Male (ref.)				1.00	1.00	1.00
Marital status						
Single				0.60 (0.19, 1.93)	0.71 (0.22, 2.30)	0.69 (0.21, 2.26)
Divorced				2.19 (0.84, 5.67)	2.18 (0.80, 5.95)	2.17 (0.80, 5.89)
Widowed				1.29 (0.67, 2.51)	1.35 (0.68, 2.66)	1.36 (0.69, 2.69)
Married (ref.)				1.00	1.00	1.00
Education (in years)						
2–11				0.78 (0.41, 1.47)	0.91 (0.47, 1.76)	0.91 (0.47, 1.77)
12, 13				1.16 (0.57, 2.34)	1.44 (0.68, 3.04)	1.43 (0.68, 3.02)
14+ (ref.)				1.00	1.00	1.00
Income						
≤ low-income cut-off				0.66 (0.25, 1.72)	0.62 (0.23, 1.68)	0.63 (0.23, 1.71)
> low-income cut-off (ref.)				1.00	1.00	1.00
Country of birth						
Canada (ref.)				1.00	1.00	1.00
Outside Canada				1.76† (0.93, 3.33)	1.63 (0.83, 3.19)	1.61 (0.82, 3.16)
Stressful events						
Yes					3.45*** (1.94, 6.12)	3.45*** (1.94, 6.12)
No (ref.)					1.00	1.00
Chronic illnesses						
0, 1 (ref.)					1.00	1.00
2–4					3.45† (0.99, 12.08)	3.41† (0.97, 11.92)
5+					6.27** (1.78, 22.15)	6.05** (1.71, 21.42)
Physical activity other than walking						1.00 (0.99, 1.01)

Continued

Table 3. Continued

Characteristics	Model 1a OR (95% CI)	Model 1b OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Hosmer & Lemeshow R^2	.02	.03	.05	.07	.15	.15
Model $\chi 2$	7.91†	14.08**	18.57*	30.39*	62.80***	63.23***

CI = confidence intervals
OR = odds ratio
Model 1a: Social participation tested separately
Model 1b: Walking tested separately
Model 2: Social participation and walking tested simultaneously
Model 3: Model 2 with control for demographic and socioeconomic characteristics (age, sex, marital status, education, income, and country of birth)
Model 4: Model 3 with control for recent stressful events and number of chronic illnesses
Model 5: Model 4 with control for physical activity other than walking
† < .10, * $p < .05$, ** $p < .01$, *** $p < .001$

(Model 2), the association between walking and possible clinical depression remained statistically significant (OR = 2.85, 95% CI: 1.48, 5.48), but the association between social participation and possible clinical depression became non-significant, although a trend towards greater likelihood of being potentially clinically depressed was observed (OR = 2.04, 95% CI: 0.88, 4.74). Participants who did not walk outside their home reported greater likelihood of being potentially clinically depressed than those who walked often, even when adjusting for demographic and socioeconomic variables (Model 3; OR = 2.85, 95% CI: 1.43, 5.68), when further controlling for stressful events and number of chronic illnesses (Model 4; OR = 2.56, 95% CI: 1.25, 5.25), and when further adjusting for physical activity other than walking (Model 5; OR = 2.57, 95% CI: 1.25, 5.28).

Social participation was not significantly associated with potential clinical depression in these models. In the final model, the rate of participants categorized as potentially clinically depressed were 6.1 per cent for those who reported never walking, 3.5 per cent for those who reported walking seldom, 2.9 per cent for those who reported walking sometimes, and 2.4 per cent for those who reported walking often outside their home. In addition to walking, the occurrence of stressful events (OR = 3.45, 95% CI: 1.94, 6.12) and reporting five or more chronic illnesses (OR = 6.05, 95% CI: 1.71, 21.42) were also associated with greater likelihood of potential clinical depression in the final model (Model 5); for the final model, the Hosmer and Lemeshow's R^2 was .15. No significant interactions between social participation and walking were identified (models not reported).

Discussion

The aim of this study was to quantify associations, among community-dwelling older adults, between depression (measured as a continuous variable and as a dichotomous variable) and the combined effects from social participation and walking (adjusting for socio-demographic variables, stressful events, number of chronic illnesses, and physical activity other than walking). The results of linear and logistic regression analyses revealed that social participation and walking were associated with the extent of depressive symptoms or possible clinical depression in bivariate analyses when tested separately: participants in the lowest quintile of social participation, and participants who did not walk outside their home, reported higher depression scores or likelihood of possible clinical depression. However, when social participation and walking were tested simultaneously, associations between walking and the extent of depressive symptoms or possible clinical depression remained significant independent of numerous factors – age, sex, marital

status, education, income, country of birth, stressful events, number of chronic illnesses, and physical activity other than walking – whereas associations between social participation and the extent of depressive symptoms or possible clinical depression were attenuated to non-significance in the final model.

Our current data are not concordant with previous studies pointing to associations between social participation and the extent of depressive symptoms or possible clinical depression independent of co-variates (Carvalhais et al., 2008; Glass et al., 2006; Isaac et al., 2009; Rozzini et al., 1996; Zunzunegui et al., 1998). Differences in assessment of social participation may explain these discrepancies. It is worth noting that our measure of social participation reflected participants' social activity level and that satisfaction with social activity may be more relevant to the extent of depressive symptoms or possible clinical depression than levels of social activity themselves. Likewise, other social dimensions of life such as social support may play a more important role in the extent of depressive symptoms and possible clinical depression than social participation. Moreover, social participation and walking may share inextricable variance (all of the items included in the social participation measure involved some amount of walking), or there may be a mediating role of walking. Other research examining the cumulative effect of social dimensions and walking on the extent of depressive symptoms or possible clinical depression among older adults is needed.

Associations between walking and the extent of depressive symptoms or potential clinical depression have been reported in other studies (e.g., Mobily et al., 1996, Smith et al., 2010). In our study, these associations were independent of physical activity other than walking. In fact, a greater level of physical activity other than walking was not associated with the likelihood of being potentially clinically depressed. In recent years, some researchers have investigated different types of walking, namely recreational walking (i.e., walking to maintain health/fitness or for enjoyment) and utilitarian walking (i.e., walking as a form of transportation to fulfill other life tasks) (Gauvin et al., 2008; Saelens & Handy, 2008). It would be interesting to investigate whether these types of walking are related differently to the extent of depressive symptoms or possible clinical depression. For example, walking for recreational reasons may be more strongly associated with lower levels of depressive symptoms or a lower likelihood of possible clinical depression than walking for utilitarian reasons. Amount and intensity of walking may also be other parameters to investigate in relation with depression because depression may, to some extent, increase at the most vigorous intensity level (Lindwall, Rennemark, Halling, Berglund, & Hassmen, 2007), when the capacity of the metabolic system is exceeded and lactate is accumulated in the body (Ekkekakis, 2003).

Four of the co-variates included in the study – being born outside Canada, the occurrence of stressful events, reporting five or more chronic illnesses, and lack of involvement in physical activity other than walking – were associated with higher depressive symptoms in linear regression analyses, whereas the occurrence of stressful events and reporting five or more chronic illnesses were associated with potential clinical depression in logistic regression analyses. Taken together, these results suggest that country of birth and lack of involvement in physical activity other than walking may be useful in understanding the extent of depressive symptoms in the general population, but possible clinical depression appears more strongly related with infrequent walking outside the home, stressful events, and multiple chronic illnesses.

One limitation of the current study is its cross-sectional nature. Moreover, because respondents in the current sample lived in urban areas and appeared more educated and wealthier than the overall population of older adults, the results may not generalize to other samples. In addition, the PASE measures activity levels over the previous week, which may be affected by atypical external (and personal) conditions such as weather (Schuit, Schouten, Westerterp, & Saris, 1997). Nevertheless, the PASE is a widely used measure that proved to be useful. Strengths of this study include the investigation of two parameters amenable to change through interventions (social participation and walking) to estimate the extent of depressive symptoms and possible clinical depression.

Although the current study does not allow for drawing conclusions about the direction of associations between walking and depression, the results are in keeping with the following interventions: (a) promoting walking as a potential protector against depression, (b) promoting walking as a relevant target of intervention for people suffering from depression, and (c) transforming urban environments to make them more walkable. Future research could examine the direction of associations between walking and depression across time: does walking predict future depressive symptoms, does depression predict future walking, or is there a bidirectional relationship between the two variables?

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (4th ed.)*. Washington, DC: American Psychiatric Association.

Blazer, D. G. (2003). Depression in late life: Review and commentary. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *58*(3), 249–265.

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Brink, T. L., Yesavage, J. A., Lum, O., Heersema, P., Adey, M. B., & Rose, T. L. (1982). Screening tests for geriatric depression. *Clinical Gerontologist*, *1*, 37–43.

Buchanan, D., Tourigny-Rivard, M.-F., Cappeliez, P., Frank, C., Janikowski, P., Spanjevic, L. et al. (2006). National guidelines for seniors' mental health: The assessment and treatment of depression. *Canadian Journal of Geriatrics*, *9*(Supp. 2), S52–S58.

Cairney, J., Faught, B. E., Hay, J., Wade, T. J., & Corna, L. M. (2005). Physical activity and depressive symptoms in older adults. *Journal of Physical Activity & Health*, *2*(1), 98–114.

Carvalhais, S. M., Lima-Costa, M. F., Peixoto, S. V., Firmo, J. O., Castro-Costa, E., & Uchoa, E. (2008). The influence of socio-economic conditions on the prevalence of depressive symptoms and its covariates in an elderly population with slight income differences: The Bambui Health and Aging Study (BHAS). *The International Journal of Social Psychiatry*, *54*(5), 447–456.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., et al. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395.

Daniel, M., & Kestens, Y. (2007). *MEGAPHONE: Montreal Epidemiological and Geographic Analysis of Population Health Outcomes and Neighbourhood Effects*. Canadian Registered Copyright (# 1046898). Montreal: Centre de recherche du Centre hospitalier de l'Université de Montréal.

Dimidjian, S., Martell, C. R., Addis, M. E., & Herman-Dunn, R. (2008). Behavioral activation for depression. In D. H. Barlow (Ed.), *Clinical handbook of psychological disorders: A step-by-step treatment manual (4th ed.)* (pp. 328–364). New York: The Guilford Press.

Ekkekakis, P. (2003). Pleasure and displeasure from the body: Perspectives from exercise. *Cognition and Emotion*, *17*(2), 213–239.

Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annual Review of Clinical Psychology*, *5*, 363–389.

Gaudreau, P., Morais, J. A., Shatenstein, B., Gray-Donald, K., Khalil, A., Dionne, I., et al. (2007). Nutrition as a determinant of successful aging: Description of the Quebec Longitudinal Study NuAge and results from cross-sectional pilot studies. *Rejuvenation Research*, *10*(3), 377–386.

Gauvin, L., Richard, L., Kestens, Y., Shatenstein, B., Daniel, M., Moore, S. D., et al. (2012). Living in a well-serviced urban area is associated with maintenance of frequent walking among seniors in the VoisiNuAge study. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *67B*(1), 76–88. doi: 10.1093/geronb/gbr134.

Gauvin, L., Riva, M., Barnett, T., Richard, L., Craig, C. L., Spivock, M., et al. (2008). Association between neighborhood active living potential and walking. *American Journal of Epidemiology*, *167*(8), 944–953.

Glass, T. A., De Leon, C. F., Bassuk, S. S., & Berkman, L. F. (2006). Social engagement and depressive symptoms in late life: Longitudinal findings. *Journal of Aging and Health*, *18*(4), 604–628.

Isaac, V., Stewart, R., Artero, S., Ancelin, M. L., & Ritchie, K. (2009). Social activity and improvement in depressive symptoms in older people: A prospective community cohort study. *American Journal of Geriatric Psychiatry*, *17*(8), 686–696.

Lawlor, D. A., & Hopker, S. W. (2001). The effectiveness of exercise as an intervention in the management of depression: Systematic review and meta-regression analysis of randomised controlled trials. *British Medical Journal*, *322*(7289), 763–767.

Lebowitz, B. D., Pearson, J. L., Schneider, L. S., Reynolds, C. F. 3rd, Alexopoulos, G. S., Bruce, M. L., et al. (1997). Diagnosis and treatment of depression in late life: Consensus statement update. *Journal of the American Medical Association*, *278*(14), 1186–1190.

Lefrançois, R., Leclerc, G., Dubé, M., Hamel, S., & Gaulin, P. (2001). Valued activities of everyday life among the very old – A one-year trend. *Activities, Adaptation and Aging*, *25*(3–4), 19–34.

Levasseur, M., Richard, L., Gauvin, L., & Raymond, E. (2010). Inventory and analysis of definitions of social participation found in the aging literature: Proposed taxonomy of social activities. *Social Science and Medicine*, *71*(12), 2141–2149.

Lindwall, M., Rennemark, M., Halling, A., Berglund, J., & Hassmen, P. (2007). Depression and exercise in elderly men and women: Findings from the Swedish national study on aging and care. *Journal of Aging and Physical Activity*, *15*(1), 41–55.

Mobily, K. E., Rubenstein, L. M., Lemke, J. H., & Wallace, R. B. (1996). Walking and depression in a cohort of older adults: The Iowa 65+ Rural Health Study. *Journal of Aging and Physical Activity*, *4*(2), 119–135.

Morgan, K., & Bath, P. A. (1998). Customary physical activity and psychological wellbeing: A longitudinal study. *Age and Ageing*, *27*(suppl 3), 35–40.

Payette, H. (2003). Développement, validation et évaluation d'un programme de dépistage nutritionnel pour les personnes âgées en perte d'autonomie vivant dans la communauté [Development, validation, and evaluation of a nutritional screening program for older adults with functional limitations living in the community]. Unpublished manuscript. Located at the Centre d'expertise de l'Institut universitaire de gériatrie de Sherbrooke, 375, rue Argyll, Sherbrooke, Province of Quebec, Canada.

Payette, H., Gueye, N. D. R., Gaudreau, P., Morais, J. A., Shatenstein, B., & Gray-MacDonald, K. (2011). Trajectories of physical function decline and psychological functioning: The Québec longitudinal study on nutrition and successful aging (NuAge). *Journals of Gerontology.*

Series B, Psychological Sciences and Social Sciences, *66B*, (suppl 1), i82–i90. doi:10.1093/geronb/gbq085.

Perrino, T., Mason, C. A., Brown, S. C., & Szapocznik, J. (2010). The relationship between depressive symptoms and walking among Hispanic older adults: A longitudinal, cross-lagged panel analysis. *Aging & Mental Health*, *14*(2), 211–219.

Reid, L. D., & Planas, L. G. (2002). Aging, health, and depressive symptoms: Are women and men different? *Journal of Women's Health*, *11*(9), 813–824.

Richard, L., Gauvin, L., Kestens, Y., Shatenstein, B., Payette, H., Daniel, M., et al. (2013). Neighborhood resources and social participation among older adults: Results from the VoisiNuAge study. *Journal of Aging and Health*, *25*(2), 296–318. DOI: 10.1177/0898264312468487.

Rozzini, R., Boffelli, S., Franzoni, S., Frisoni, G. B., & Trarucchi, M. (1996). Prevalence and predictors of depressive symptoms in a nursing home. *International Journal of Geriatric Psychiatry*, *11*(7), 629–634.

Saelens, B. E., & Handy, S. L. (2008). Built environment correlates of walking: A review. *Medicine and Science in Sports and Exercise*, *40*(7 Suppl), S550–S566.

Schuit, A. J., Schouten, E. G., Westerterp, K. R., & Saris, W. H. M. (1997). Validity of the physical activity scale for the elderly (PASE): According to energy expenditure assessed by the doubly labeled water method. *Journal of Clinical Epidemiology*, *50*(5), 541–546.

Simonsick, E. M., Guralnik, J. M., & Fried, L. P. (1999). Who walks? Factors associated with walking behavior in disabled older women with and without self-reported walking difficulty. *Journal of the American Geriatrics Society*, *47*(6), 672–680.

Smith, T. L., Masaki, K. H., Fong, K., Abbott, R. D., Ross, G. W., Petrovitch, H., et al. (2010). Effect of walking distance on 8-year incident depressive symptoms in elderly men with and without chronic disease: The Honolulu-Asia Aging Study. *Journal of the American Geriatrics Society*, *58*(8), 1447–1452.

Statistics Canada. (2004). *Low income cutoffs from 1994-2003 and low-income measures from 1992-2001. Income Research Paper Series*. Ottawa, ON: Statistics Canada.

Washburn, R. A., Smith, K. W., Jette, A. M., & Janney, C. A. (1993). The physical activity scale for the elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology*, *46*(2), 153–162.

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, L., Huang, V., Adey, M., et al. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, *17*(1), 37–49.

Yoshiuchi, K., Nakahara, R., Kumano, H., Kuboki, T., Togo, F., Watanabe, E., et al. (2006). Yearlong physical activity and depressive symptoms in older Japanese adults: Cross-sectional data from the Nakanojo study. *American Journal of Geriatric Psychiatry*, *14*(7), 621–624.

Zunzunegui, M. V., Béland, F., Llácer, A., & León, V. (1998). Gender differences in depressive symptoms among Spanish elderly. *Social Psychiatry and Psychiatric Epidemiology*, *33*(5), 195–205.