Depression statuses and related predictors in later life: A 10-year follow-up study in Israel

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Published online: 28 June 2016
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Abstract The aim of the current study was to investigate the factors associated with depression statuses in a 10-year follow-up of community-dwelling older adults in Israel. Longitudinal data were used from the Israeli sample of the Survey of Health, Aging and Retirement in Europe, assessing the depressive symptoms in 1042 respondents, aged 50 or above, at three time points: 2004/2005 (Wave I); 2009/2010 (Wave II); and 2014/2015 (Wave III). Multinomial logistic regression was used to determine the relationships among explanatory variables and depression statuses (no-depression, intermittent depression, or persistent depression). Some 46.5 % of the participants suffered from intermittent or persistent depression. Five factors were associated with increasing the probability of both intermittent and persistent depression: being female, unemployed, less educated, physically disabled, and in poor health. Five other explanatory variables were associated only with a higher risk for persistent depression: low family income, widowhood, physical inactivity, more than two chronic diseases, and cognitive dysfunction. According to these findings, depression is common among older people in Israel. Low socio-economic status and poor subjective and physical health are significant determinants of depression statuses over time, underlining the importance of taking measures to improve these conditions in order to reduce the risk of depression in old age.

Keywords Depression symptoms · Longitudinal study · Socio-economic resources · Health-related factors · Persistent depression

Introduction

Depression, which is widespread in later life (Beekman et al. 1999; Blay et al. 2011; Byers et al. 2012; Castro-Costa et al. 2007; Djernes 2006; Lorant et al. 2003; Sutin et al. 2013), takes various forms. These include persistent, intermittent, recovery, recurrent, onset, and incidence depression over time (Lorant et al. 2003; Mechakra-Tahiri et al. 2013; Melchior et al. 2013; Sutin et al. 2013). Among the older people, depression may lead to poor quality of life, numerous illnesses (e.g., cancer and cardiac disease), cognitive dysfunction and functional disability (Alexopoulos 2005; Dines et al. 2014; Penninx et al. 1998), as well as to increased mortality (Alexopoulos 2005) and suicide rates (Blazer 2003; Dines et al. 2014).

A growing body of recent longitudinal studies has investigated the mechanisms and interrelationships between risk factors (e.g., socio-economic resources and health factors) and depression patterns/trajectories among older people (Lorant et al. 2003; Mechakra-Tahiri et al. 2013; Melchior et al. 2013). As the findings indicate, health factors account for the link between socio-economic factors and depression (Cole and Dendukuri 2003; Melchior et al. 2013; Miech and Shanahan 2000).

However, no longitudinal study has been conducted thus far in Israel on the predictors of depression statuses. Such a study is necessary to examine if the particular circumstances of Israel's past and present yield different results about the relationships between SES and health indicators, on the one hand, and depression in later life, on the other

Responsible Editor: Sharon Shiovitz-Ezra (guest editor) and Howard Litwin.

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hand, compared to other populations around the world. Such research on this topic in Israel is warranted due to the considerable and unique disparities that exist in many aspects of life in this country (Baron-Epel et al. 2005; Na'amni et al. 2010; Okun and Friedlander 2005).

Moreover, identification of the potentially modifiable risk factors in the older Israeli population is important from both policy and public health perspectives. Consequently, the current study examines the correlations of socio-economic and health factors in relation to the various statuses of depression over time, in order to identify the risk factors that might be ameliorated by means of public programs.

Background

Socio-economic status, which is the major contributing factor to depression among older persons, is a multidimensional concept. It includes three types of resources: material standard of living (e.g., household income), skills (e.g., educational level and employment status), and social relationships (marital status, family support, and participation in social activities) (Lorant et al. 2003; Miech and Shanahan 2000; Oakes and Rossi 2003). According to longitudinal studies, low socio-economic status is associated with a high risk of late-life depression (Lorant et al. 2003; Melchior et al. 2013), whereas long-term improvement in socio-economic measures would be expected to reduce depressive symptoms (Lorant et al. 2003). A meta-analysis carried out by Lorant et al. (2003) showed that low socio-economic level slightly increases the risk of episode-onset depression and moderately increases the risk of persistent depression.

Income is the most robust predictor of depression among the aging (Lorant et al. 2003). An association between inadequate income and depressive symptoms was found in a cross-sectional study (Kessler et al. 2003). In longitudinal studies, the risk of an episode of depression was found to be significantly increased among participants with decreased household incomes (Beard et al. 2008); a dose-response relationship between income and depression has been documented (Beard et al. 2008; Lorant et al. 2003).

Education is another socio-economic factor highly associated with depression over time. As consistently shown, less well-educated older persons are at a greater risk for depression (Blay et al. 2011; Chang-Quan et al. 2010; Chiao et al. 2011; Hong et al. 2009; Lorant et al. 2003; Strawbridge et al. 2002; Yang 2007); a dose-response relationship between educational level and depression was shown (Lorant et al. 2003). Although education tends to remain stable throughout adulthood, the relationship between education and depression increases with age (Miech and Shanahan 2000).

Adults who continue to work full- or part-time in old age and have more social and economic resources than those who are not employed suffer from fewer depressive symptoms (Chiao et al. 2011; Jang et al. 2009a). According to another study, the risk of persistent as well as intermittent depression was associated with lower occupational grade (Melchior et al. 2013).

Social environment is also associated with depressive symptoms over time. Older adults living with partners report less depression than those who are single, separated, divorced, or widowed (Beard et al. 2008; Jang et al. 2009b; Melchior et al. 2013; Schoevers et al. 2000; Taylor and Lynch 2004). The risk of persistent depression is higher among those separated than those living with partners (Mechakra-Tahiri et al. 2013). Widowhood is associated with persistent depression in women (Montagnier et al. 2014). While starting to live with a partner decreased the depressive symptoms, ceasing to live with a partner increased them (Lorant et al. 2003).

Adults with small family networks feel more loneliness, less support, and show more depressive symptoms than those with larger networks (Byers et al. 2012; Strawbridge et al. 2002). As shown by longitudinal studies, continuous or initiated participation in social activities in later life is associated with fewer depressive symptoms (Chiao et al. 2011; Glass et al. 2006; Hong et al. 2009), and may also alleviate existing depression (Cruwys et al. 2013).

Health-related aspects are particularly important risk factors for depression in older adults (Ball et al. 2009; Beard et al. 2008; Blazer 2003; Byers et al. 2012; Geerlings et al. 2000; Yang 2007). Chronic diseases, which are common in old age, have been shown to be longitudinally associated with the onset of depressive symptoms (Buber and Engelhardt 2011; Chiao et al. 2011; Gale et al. 2011; Geerlings et al. 2000; Huang et al. 2011; Melchior et al. 2013; Schoevers et al. 2000) and persistent depression (Byers et al. 2012; Mechakra-Tahiri et al. 2013). Self-rated health was also correlated with depression in later life in longitudinal studies (Han and Jylha 2006; Hong et al. 2009; Huang et al. 2011; Khalaila and Litwin 2014; Cole and Dendukuri 2003).

Physical disability is the health factor most highly correlated with depression in older age. Disability raising the frequency of negative life events, restrictions on valued activities, and isolation (Blazer 2003) increases the risk for major depression (Braam et al. 2005; Buber and Engelhardt 2011; Gale et al. 2011; Geerlings et al. 2000; Khalaila and Litwin 2014; Cole and Dendukuri 2003; Yang and George 2005) and persistent depression (Byers et al. 2012). Physical disability is also associated with the direction and rate of deterioration in depressive symptoms among older men and women (Huang et al. 2011).

Correlations between cognitive dysfunction in later life and depression have been shown in both cross-sectional (Blazer 2003; Wilkins et al. 2009) and longitudinal studies (Cole and Dendukuri 2003; Schoevers et al. 2000). While depressive symptoms often featured together with dementia and cognitive or memory impairment (Gaugler et al. 2007; Wilkins et al. 2009), the mechanisms and causal relations between them remain unclear.

Obesity or weight gain in later life, studied longitudinally, increased the risk of developing depressive symptoms (Ball et al. 2009; Byers et al. 2012; Khalaila and Litwin 2014; Melchior et al. 2013; Strawbridge et al. 2002), both the prevalence and incidence of depression (Singh et al. 2014). Increased body mass index (BMI) was associated with an increased chance of depressive symptoms (Ball et al. 2009).

Unhealthy behaviors (physical inactivity and smoking) in later life were also associated with depression over time (Duijs et al. 2011; Khalaila and Litwin 2014). In longitudinal studies, physical inactivity and/or reduced intensity of physical activity in later life were risk factors for depression (Byers et al. 2012; Duijs et al. 2011; Strawbridge et al. 2002). As shown by a systematic review of observational and intervention studies, physical activity of both short and long duration reduced the likelihood of depression (Teychenne et al. 2008). In one longitudinal study, initial levels of physical activity were negatively associated with changes in depressive symptoms over time (Ku et al. 2012).

In several longitudinal studies, current and former smokers were significantly more likely to exhibit depressive symptoms than nonsmokers (Byers et al. 2012; Melchior et al. 2013; Strawbridge et al. 2002). As shown in several cross-sectional studies, moreover, both past and current heavy smoking were associated with increased frequency and severity of depression (Almeida and Pfaff 2005; Blay et al. 2011).

Demographic characteristics are also related to depression in later life, including age (Strawbridge et al. 2002), female gender (Beard et al. 2008; Hong et al. 2009; Huang et al. 2011; Taylor and Lynch 2004), and minority group ethnicity (Strawbridge et al. 2002; Walsemann et al. 2009). The incidence of depression has been found to be significantly higher among older Israeli Arabs than among their Jewish counterparts (Kaplan et al. 2010; Khalaila and Litwin 2014).

Methods

Participants

This study is based on three waves of the Israeli component of the Survey of Health, Aging and Retirement in Europe

(SHARE). The data were collected in 2005–2006, 2009–2010, and 2013. The baseline sample was initially comprised 2598 respondents, including participants aged 50 and older and their spouse of any age. The current analysis was limited to the respondents aged 50 + at baseline ($n = 2484$). It was also limited to those with data on depressive symptoms in all three waves, so as to allow the construction of the dependent variable—depression statuses (no-depression, intermittent, or persistent depression). The analytic sample thus numbered 1042 persons (42 % of the respondents aged 50 + in Wave I). Among those excluded from the current study sample, more than 300 had died during the respective follow-up periods and the remainder had missing values due to unanswered questions or not participating in one or both of the subsequent waves. For more details on the sample please, see Fig. 1.

Comparing the characteristics of respondents with complete data to those with incomplete data revealed that the latter were more likely to be Arab, male, relatively younger, widowed, less socially active, in lower socioeconomic positions (less educated, lower family incomes, and unemployed), and engaged in unhealthy behaviors (such as physical inactivity). They also reported poorer baseline health, including subjective health, chronic diseases, functional disability, and cognitive dysfunction (data not shown).

Measures

Depression was assessed on the EURO-Depression scale, which was developed to compare depressive symptoms across European countries (Prince et al. 1999). It covers 12 symptom domains: depressed mood, pessimism, suicidal tendencies, guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment, and tearfulness. Each item was rated 0 (absent) or 1 (present). The total score ranges from 0 to 12, in the direction of greater depressive symptoms. Dewey and Prince (2005) define clinically significant depression as EURO-D scores above 3. Therefore, the score in this study was dichotomized, as follows: 3 or less = "0" and greater than 3 = "1," with depression. Next, participants with complete Euro-depression data were categorized as without depression (reference), or with intermittent (at least one wave) or persistent depression (at three waves).

Health-related factors include four measures: self-perceived health, physical health (chronic disease), obesity, functional disability, and cognitive dysfunction. The *European Version of self-perceived health* in Wave I was determined from the respondents' descriptions of their (poor) general health on a scale ranging from "very good" to "very bad" (dichotomized here as (1) "less than good

	Wave I	Wave II	Wave III
Total = 2,484	No depression = 1562	No depression = 894	No depression = 519
			Depression = 66
			Missing values = 309
		Depression = 200	No depression = 65
			Depression = 35
			Missing values = 100
	Depression = 832	Missing values = 468	No depression = 80
			Depression = 9
			Missing values = 379
		No depression = 222	No depression = 91
			Depression = 37
			Missing values = 94
		Depression = 250	No depression = 42
			Depression = 74
			Missing values = 134
	Missing values = 90	Missing values = 360	No depression = 20
			Depression = 23
			Missing values = 317
		No depression = 15	No depression = 6
			Depression = 0
			Missing values = 9
		Depression = 19	No depression = 2
			Depression = 2
			Missing values = 15
		Missing values = 56	No depression = 3
			Depression = 3
			Missing values = 50

Fig. 1 Depression patterns among the participants aged 50 or over in Wave I, and the follow-up surveys in Waves II and III ($n = 2484$)

(fair, bad or very bad)” and (0) “good or more (very good or good)”).

In terms of *physical health*, respondents specified whether they were ever diagnosed with a chronic illness from a list of 14 in the first wave of the survey: heart failure, hypertension, cerebral vascular disease, diabetes, hyperlipidemia, chronic lung disease, asthma, arthritis, osteoporosis, cancer, peptic ulcer, Parkinson’s disease, cataracts, and hip or femoral fracture. The measure was dichotomized here as (0) “less than two diseases” and (1) “two or more diseases.”

Obesity was assessed according to BMI (body mass index): weight in kg divided by height in meters squared. Weight and height variables were self-reported. BMI scores over 30 indicated unhealthy weight gain or obesity (1), while scores less than 30 indicated the absence of obesity (0).

Functional disability was identified in Wave I as reported difficulties in activities of daily living (ADL) (Katz et al. 1970) in the following six areas, on a scale of 0–6: dressing, bathing, eating, transfers, walking across the room, and using the toilet. The score was dichotomized as (0) “no ADL difficulty” and (1) “one or more ADL difficulty.”

Cognitive dysfunction was determined in Wave I by evaluating the respondents’ orientation to date, month, year, and day of week, on a 5-point scale, ranging from

“bad” to “good.” The variable reflecting cognitive dysfunction in the present analysis was dichotomized as less than good (1) and good (0).

Two *health behaviors* were addressed in Wave I: smoking and physical inactivity (Khalaila and Litwin 2014). Smoking was measured as a dichotomous variable of “nonsmoker or former smoker” (0), or “current smoker” (1). Two levels physical activity were defined as follows: “no physical activity (neither vigorous nor moderate)” (0) or “moderate to vigorous physical activity” (1).

The *socio-economic resources* included six variables in Wave I: number of children (>3 or ≤ 3 children); employment status, marital status; participation in social activities; education; and family income (Blay et al. 2011; Glass et al. 2006). Employment status includes presently employed or self-employed (0), retired (1), or unemployed (including unemployed; permanently sick or disabled; and homemaker) (2). Marital status was classified as living with partner (0); divorced/never married (1); or widowed (2). A participation in social activities indicator measures involvement in five areas in the month preceding Wave I, including voluntary or charity work, and taking part in a political or community organization. The total score was categorized as (0) “did not participate in any activities”; (1) “one activity”; and (2) “two or more activities.” Education level was coded as (0) 0–6 years of education; (1) 7–12 years; or (2) more than 12 years. Family income

was measured from the total monthly cash and in-kind income received by household members from all sources in Euros, dichotomized by the median income in the sample as (0) less than €1900, or (1) €1900 or more.

Demographic characteristics were obtained in Wave I: gender (female = 1; male = 0); ethnicity (1 = Arab; 0 = Jewish); and age (0) = 50- to 64-year old; (1) = 65–74; and (2) 75 years old or more.

Data analysis

First, descriptive statistics were used to calculate the means and standard deviations of the continuous variables and the percentages and frequencies of the categorical variables. χ^2 tests on the data identified unadjusted differences between depression statuses (no-depression, or intermittent or persistent depression) by demographic variables, socio-economic resources, health behaviors, and health-related factors obtained in Wave I ($p < 0.05$). Finally, the relationships between independent variables and depression statuses were assessed by multinomial (polytomous) logistic regression, with “no depression” serving as the reference category. The Statistical Package for Social Sciences (SPSS) version 20.0 was used for the data analysis. Odds ratio and 95 % confidence intervals indicate the effect of each predictor and whether it met statistical significance. χ^2 tests and log likelihood indicate whether the set of factors in each model reliably predicts the outcome. Nagelkerke’s statistic (pseudo R^2) shows the total variance accounted for in the models.

Results

Women accounted for the majority of the study population (58.2 %). The age range was 50–96 years (Mean = 61.9, SD = 8.3). About 89.1 % were Jews, and 10.9 % were Arabs. Most of the participants had partners (81.1 %) and did not work, meaning they were unemployed (20.5 %) or retired (37.2 %). The mean years of education was about 12.0 (SD = 4.8, range 0–25), with some 57.6 % reporting 12 or less years of education. The median family income was about €1900, ranging from €0 to €25,150 (Mean = € 2825, SD = € 2859). The mean number of children was 3.3 (median = 3, SD = 2.0, range 0–16) (data not shown).

About 28 % of the sample in Wave I, 25 % in Wave II, and 24.6 % in Wave III scored over 3 on the EURO-Depression scale (ranging from 0 to 12), the threshold risk for clinical depression (Dewey and Prince 2005). In addition, 53.5 % did not show any depression throughout the study; 8.7 % suffered from persistent depression in Waves I, II,

and III, and 37.8 % from intermittent depression (data not shown).

As shown in Table 1, all the Wave I demographic variables, except for ethnicity, were related to depression statuses. Women and older respondents were more depressed. Socio-economic resources were also significantly correlated with depression statuses, but not number of children. Those with lower education levels, not currently working (unemployed or retired), with family incomes of less than €1900, and living without a partner (never married, divorced, or widowed) were more depressed. However, those involved in two or more social activities were less likely to be depressed.

As shown in Table 2, physical activity was related to depression statuses, while smoking was not. Respondents who were physically active in Wave I were less likely to be depressed than those who were inactive. In addition, those with obesity, poor subjective health, chronic diseases, cognitive dysfunction, and functional disability were more likely to be depressed.

Table 3 shows the results of the multinomial (polytomous) logistic regression model with the dependent variable as depression statuses (with no, intermittent, or persistent depression). The model was significant and useful [χ^2 (34, 1042) = 308.2, $p < 0.001$]. The results identified a set of ten predictors of depression statuses over the 10-year follow-up, with pseudo $R^2 = 0.32$, including the demographic variable of gender; four socio-economic resources (education, family income, employment status, and marital status), the health behavior of physical activity, and four health-related factor (self-rated health, chronic diseases, ADL, and cognitive dysfunction).

The female respondents were more likely than the males to show intermittent or persistent depression, rather than absence of depression. Four socio-economic resources were associated with both depression statuses. Those with 12 years of education or less were more likely to suffer from intermittent and persistent depression, rather than showing the no-depression status. A dose-response relationship between education levels and depression statuses was also found. Thus, the risk for persistent and intermittent depression increased with a shift from low education (0–6 years) to the middle category (7–12 years), as compared to a shift to a high education level (13 years or more). Unemployed participants were also more likely to have intermittent and persistent depression statuses, rather than the reference category, whereas retired participants were more likely to report only persistent depression status than those who were unemployed.

In addition, marital status and family income were found to be significant only for the persistent depression. Widowed participants were more likely to report persistent depression than those living with partners, whereas there

Table 1 Depression status and demographic and socio-economic variables in Wave I: descriptive statistics and bivariate analysis ($n = 1042$)

Variables	Measurement	Depression Status—EURO-D			Test/ <i>p</i> value
		No-depression <i>n</i> (%)	Intermittent depression <i>n</i> (%)	Persistent depression <i>n</i> (%)	
Demographic variables					
Ethnicity	Arab	55 (48.2)	48 (42.1)	11 (9.6)	$\chi^2 = 1.39$
	Jewish	502 (54.1)	346 (37.3)	80 (8.6)	
Gender	Female	284 (46.9)	260 (42.9)	62 (10.2)	$\chi^2 = 25.4^{***}$
	Male	273 (62.6)	134 (30.7)	29 (6.7)	
Age	50–64	376 (56.2)	249 (37.2)	44 (6.6)	$\chi^2 = 23.53^{***}$
	65–74	143 (52.6)	101 (37.1)	28 (10.3)	
	75+	37 (37.0)	44 (44.0)	19 (19.0)	
Socio-economic resources					
Education (years)	0–6	36 (30.8)	53 (45.3)	28 (23.9)	$\chi^2 = 92.79^{***}$
	7–12	219 (45.9)	212 (44.4)	46 (9.6)	
	13+	297 (67.2)	129 (29.2)	16 (3.6)	
Marital status	With partner	466 (55.3)	318 (37.7)	59 (7.0)	$\chi^2 = 13.04^{***}$
	Never married/divorced	40 (48.8)	32 (39.0)	10 (12.2)	
	Widowed	49 (42.6)	44 (38.3)	22 (19.1)	
No. of children	≤3	272 (55.7)	177 (36.3)	39 (8.0)	$\chi^2 = 4.95$
	>3	122 (49.4)	94 (38.1)	31 (12.6)	
Participation in social activities	0	57 (46.7)	53 (43.4)	12 (9.8)	$\chi^2 = 9.44^*$
	1	383 (52.5)	278 (38.1)	69 (9.5)	
	2+	117 (62.2)	61 (32.4)	10 (5.3)	
Employment status	Unemployed	66 (31.3)	106 (50.2)	39 (18.5)	$\chi^2 = 89.01^{***}$
	Retired	194 (50.7)	148 (38.6)	41 (10.7)	
	Employed	287 (65.8)	138 (31.7)	11 (2.5)	
Monthly family income	≤1900 €	232 (45.6)	209 (41.1)	68 (13.4)	$\chi^2 = 38.7^{***}$
	>1900 €	325 (61.0)	185 (34.7)	23 (4.3)	

** $p < 0.01$; *** $p < 0.001$

was no difference between those who were never married/divorced and those living with partners. High family income was associated with a low risk of persistent depression. However, participation in social activity was not correlated with depression statuses.

Physical activity was the only health behavior related to depression statuses. Respondents who were physically active were less likely to suffer from intermittent or persistent depression. Health-related factors also significantly contributed to the dependent variable. Two of the health variables (self-rated health and physical disability) were significant in distinguishing both intermittent and persistent depression from the reference no-depression category. Perceived poor health and physical disability were associated with a higher probability of both forms of depression statuses, compared to the reference group. Participants with two or more chronic diseases and those with cognitive dysfunction were associated with the risk for persistent, but not intermittent depression.

Discussion

The current study examined risk factors associated with the risk of late-life depression among older Israeli adults. Almost half of the participants in a nationally representative sample of older community-dwelling Israeli adults reported experiencing intermittent or persistent depression. Moreover, like in other countries, the analysis revealed that several key factors were associated with the risk of late-life depression in Israel. Socio-economic resources, health measures, health behaviors, and demographic variables were all found to affect the prevalence of intermittent or persistent depression.

Health indicators, particularly physical disability, were major predictors of depression statuses during the follow-up period. Physical disability (ADL) was most effective in predicting intermittent and persistent depression over time. These findings support previous studies consistently demonstrating more severe depressive symptoms among

Table 2 Depression status and health behaviors and health-related factors in Wave I: descriptive statistics and bivariate analysis ($n = 1042$)

Variables	Measurement	Depression status—EURO-D			Test/ <i>p</i> value
		No-depression <i>n</i> (%)	Intermittent depression <i>n</i> (%)	Persistent depression <i>n</i> (%)	
Health behaviors					
Physical activity	No	47 (31.5)	63 (42.3)	39 (26.2)	$\chi^2 = 78.0^{***}$
	Yes	508 (57.1)	330 (37.1)	51 (5.7)	
Current smoker	No	471 (53.7)	327 (37.3)	79 (9.0)	$\chi^2 = 0.94$
	Yes	86 (52.1)	67 (40.6)	12 (7.3)	
Health-related factors					
Self-rated health	Very good/good	433 (64.5)	214 (31.9)	24 (3.6)	$\chi^2 = 118.08^{***}$
	Less than good	124 (33.4)	180 (48.5)	67 (18.1)	
Chronic disease	Less than two diseases	345 (60.8)	197 (34.7)	25 (4.4)	$\chi^2 = 42.43^{***}$
	Two + chronic diseases	212 (44.6)	197 (41.5)	66 (13.9)	
Obesity	BMI < 30	452 (55.5)	296 (36.3)	67 (8.2)	$\chi^2 = 3.93$
	BMI ≥ 30	97 (48.3)	88 (43.8)	16 (8.0)	
ADL limitations	No limitations	548 (56.8)	354 (36.7)	63 (6.5)	$\chi^2 = 104.21^{***}$
	Yes (one + limitations)	9 (11.7)	40 (51.9)	28 (36.4)	
Cognitive dysfunction	Less than good	51 (33.1)	66 (42.9)	37 (24)	$\chi^2 = 63.59^{***}$
	Good	506 (57.0)	328 (36.9)	54 (6.1)	

*** $p < 0.001$

those older persons with greater disability, particularly in the physical realm (Byers et al. 2012; Khalaila and Litwin 2014; Schoevers et al. 2000; Taylor and Lynch 2004; Huang et al. 2011; Yang and George 2005). Physical disability leads to loss of dignity, which may explain the depressive symptoms in such cases (Gale et al. 2011; Geerlings et al. 2000). It is also possible that employment status underlies both these variables: the disabled or ill older are more likely to be unemployed, and thus more susceptible to intermittent or persistent depression than those remaining employed or retired.

Perceived poor health was also associated with a greater risk of developing depressive symptoms during the follow-up period. Previous longitudinal studies also identified this pattern of exacerbated depressive symptoms with self-perceived decline in health (Han and Jylha 2006; Hong et al. 2009; Huang et al. 2011; Khalaila and Litwin 2014). Thus, self-rated health seems to be a reliable and robust predictor of mental health over time; improved subjective health may decrease the depressive symptoms.

Chronic disease was associated with an intensified risk of developing persistent, but not intermittent depression, supporting previous longitudinal studies (Braam et al. 2005; Duvis et al. 2011; Gale et al. 2011; Hong et al. 2009; Huang et al. 2011; Melchior et al. 2013; Yang 2007). This may be explained by the progressive long-term and continuous biological mechanisms underlying chronic diseases, which give rise to persistent depressive symptoms. For example, chronic conditions such as heart disease might inevitably

lead to decreased physical and mental ability, culminating in depression (Dunlop et al. 2004).

Older respondents with cognitive dysfunction were found to be more likely to suffer from persistent, but not intermittent depression. This finding reinforces the bidirectional relationship between dementia/cognitive dysfunction and depression in old age (Blazer 2003; Dines et al. 2014; Cole and Dendukuri 2003; Wilkins et al. 2009). Moreover, decline in memory, dementia, and other cognitive abilities, known to be a common feature of aging, is associated with functional disability (Gaugler et al. 2007). Therefore, the association between cognitive dysfunction\ dementia and depression is likely mediated by other health characteristics common to both variables, such as physical disability.

In addition, the results show significant correlation of health behaviors (physical activity) with depressive symptoms: physical activity decreases the risk of developing persistent depression. This finding supports previous longitudinal studies pointing to continued physical activity as conferring protection against depression in later life (Khalaila and Litwin 2014; Ku et al. 2012; Strawbridge et al. 2002; Teychenne et al. 2008). It also reinforces research indicating a correlation between lack of physical activity and a high risk for depression (Byers et al. 2012; Duvis et al. 2011). Possibly, the correlation between physical activity and depression is mediated by a common health variable, such as functional disability. As shown by previous studies, physical activity in later life lowers the risk of developing physical limitations (Miller et al. 2000;

Table 3 Multinomial logistic regression models predicting depression status ($n = 1042$)

Variables	Intermittent depression [#]		Persistent depression [#]	
	OR	95 % CI	OR	95 % CI
Gender				
Male	1.00		1.00	
Female	1.9***	1.5–2.7	1.8*	1.01–3.3
Age				
50–64	1.00		1.00	
65–74	0.9	0.6–1.5	0.9	0.5–2.0
75+	1.5	0.8–2.7	1.6	0.6–4.2
Education				
13+	1.00		1.00	
7–12	1.8***	1.3–2.5	2.1**	1.07–4.1
0–6	2.6***	1.5–4.6	4.5***	1.8–11.5
Employment status				
Employed	1.00		1.00	
Retired	1.1	0.8–1.7	2.4*	1.01–5.9
Unemployed	1.7*	1.07–2.5	3.6**	1.5–8.5
Monthly family income				
>1900€	1.00		1.00	
≤1900€	1.07	0.8–1.5	1.8*	1.04–3.4
Marital status				
Living with partner	1.00		1.00	
Never married/divorced	1.06	0.6–1.8	1.5	0.7–3.6
Widowed	0.9	0.5–1.5	1.8*	1.05–3.9
Participation in social activities				
No activity	1.00		1.00	
One activity	0.8	0.5–1.5	0.5	0.3–1.3
Two or more activities	0.9	0.5–1.3	0.6	0.2–1.7
Physical activity				
No	1.00		1.00	
Yes	0.7	0.5–1.2	0.3***	0.1–0.6
Self-rated health				
Very good/good	1.00		1.00	
Less than good	2.0***	1.5–2.9	3.2***	1.7–6.0
Chronic disease				
Less than two diseases	1.00		1.00	
Two + chronic diseases	1.2	0.8–1.6	2.0*	1.02–3.6
ADL limitations				
No limitations	1.00		1.00	
Yes (one + limitations)	3.8***	1.7–8.3	6.7***	2.6–17.0
Cognitive dysfunction				
Good	1.00		1.00	
Less than good	1.3	0.8–2.0	2.3*	1.1–4.4
Model				
–2log Likelihood	1548.37			
χ^2	308.2***			
Nagelkerke R^2	0.32			

[#] compared to group with no-depression at any survey wave

CI confidence interval, OR odds ratio

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Paterson and Warburton 2010). Another explanation suggests that physiological pathways mediate between physical activities and depressive symptoms. Physical activity may activate endorphin secretion, leading to euphoric sensations, in turn, reducing the risk of depression (Khalila and Litwin 2014; Paluska and Schwenk 2000).

As the current study shows, there were significant associations between socio-economic resources and depression. Education was the most effective socio-economic measure for predicting individual depression. A dose-response relation was also observed. That is, the lower the education level, the higher the risk was for having intermittent or persistent depression. This confirms the role of education in decreasing depressive symptoms over time in many previous studies (Blay et al. 2011; Chiao et al. 2011; Hong et al. 2009; Lorant et al. 2003; Strawbridge et al. 2002; Taylor and Lynch 2004). It also confirms the robust association that exists between low education level and greater susceptibility to depressive symptoms in later life (Chang-Quan et al. 2010). However, the education-depression pathway is still not well understood, particularly since the education level remains stable and low throughout adulthood in the current sample. This aspect should be further investigated and clarified in future studies.

Also shown in this analysis, the unemployed and retired participants were more likely to be at risk for depression than those who were employed. The unemployed had a higher risk of intermittent and persistent depression, while the retired participants were only more likely to be persistently depressed, as compared to those who were employed. These data support previous longitudinal findings pointing to the correlation between work and decreased risk of depression (Chiao et al. 2011; Jang et al. 2009a). The findings highlight the benefits of remaining employed, even if only part-time, in later life. The impact of employment status on depression was most likely mediated by other socio-economic resources, such as income. This is plausible since the effects of other socio-economic variables (such as education and employment status) are mediated by income.

As the current results show, lower family income was associated with persistent depression among the respondents, confirming previous results around the world (Beard et al. 2008; Kessler et al. 2003; Lorant et al. 2003). This may relate to the known positive association between high income and better physical health. In the current study, better physical health was related to a decreased risk of persistent depression.

Marital status is another socio-economic variable found to be significantly associated with persistent depression. The results showed that widowed participants were more likely to be depressed over time than those who were married, and even more so than the single and divorced. This reinforces other studies comparing married and unmarried respondents

(Melchior et al. 2013; Schoevers et al. 2000; Taylor and Lynch 2004), and the widowed persons to those never married or divorced (Cole and Dendukuri 2003; Montagnier et al. 2014). The fact that the majority (78 %) of the widowed participants were women may explain this result.

Women were found to be more likely to suffer from intermittent or persistent depression than males, confirming many previous longitudinal studies (Beard et al. 2008; Blay et al. 2011; Huang et al. 2011; Strawbridge et al. 2002; Taylor and Lynch 2004; Yang 2007). Thus, being female seems to be a risk factor for depression. Future studies should analyze the moderating effects of gender on the relationships between risk factors and depression patterns over time.

Limitations

A few limitations of the present analysis should be mentioned. First, on the one hand, the assessment of depression was based on a screening tool, which is less specific than definite diagnostic measures. This might carry the risk of false positives. On the other hand, the real rate of depression in the sample might be much higher than in the current analysis since those with incomplete data include many cases with low socio-economic scores and poor health in most of the indicators, as compared to the group with complete data, possibly leading to false negative findings. Despite this limitation, the findings highlight the need for interventions to identify depression among the older persons in the early stages, followed by treatment to prevent its potential later ramifications, such as suicide and high co-morbidity and mortality (Alexopoulos 2005; Dines et al. 2014; Duivis et al. 2011).

Another limitation is that despite the study's longitudinal nature, the ability of this analysis to predict a causal association between the variables remains incomplete. Other possible limitations affecting the selection bias relate to the decision to exclude incomplete data from the current analysis, and the low number of Arab respondents. Participants excluded from this analysis were more likely to be Arabs with a low socio-economic status and poor health. Despite these limitations, however, this large longitudinal, nationwide community-based survey in Israel sheds light on socio-economic and health measures that are related to depression statuses in older adults.

Conclusion

Despite the uniqueness of Israeli society, the predictors of late-life depression in this country are similar to those found in other societies. The current study shows that, as in

other countries, socio-economic indicators (i.e., education level, family income, marital status, and employment status), as well as health behaviors (e.g., physical activity) and health-related factors (e.g., subjective health, poor physical health, functional disability, and cognitive dysfunction) affect depression statuses at various levels in older adults in Israel. Modifying education and employment status in the present older cohort in Israeli is no longer feasible. However, improving such opportunities earlier in life could have a long-term positive impact on reducing depression inequalities in the future older adults. These suggestions are supported by Lorant et al. (2003) who showed that improving socio-economic factors had long-term effects in reducing depressive symptoms.

This study also has implications for healthcare policy and service, suggesting the need for prevention programs, based on both objective and subjective health measures, and health behaviors, such as physical activity. Interventions to increase physical activity among older adults might contribute to decreasing the risk of persistent depression. Similarly, these findings highlight the need for intervention programs focused on improving physical, functional, cognitive and subjective health, to prevent the development of depressive symptoms.

Finally, future studies should also explore the complex mechanisms whereby socio-economic factors and health measures impact and interrelate with respect to the development of depressive symptoms over time. Analysis of depression trajectories over time, using mixed linear models is also recommended.

References

- Alexopoulos G (2005) Depression in the elderly. *Lancet* 365:1961–1970
- Almeida OP, Pfaff JJ (2005) Depression and smoking amongst older general practice patients. *J Affect Disord* 86(2–3):317–321
- Ball K, Burton NW, Brown WJ (2009) A prospective study of overweight, physical activity, and depressive symptoms in young women. *Obesity* 17(1):66–71
- Baron-Epel O, Kaplan G, Haviv-Messika A, Tarabeia J, Green MS, Kaluski DN (2005) Self-reported health as a cultural health determinant in Arab and Jewish Israelis: MABAT—national health and nutrition survey 1999–2001. *Soc Sci Med* 61:1256–1266
- Beard JR, Tracy M, Vlahov D, Galea S (2008) Trajectory and socioeconomic predictors of depression in a prospective study of residents of New York City. *Ann Epidemiol* 18(3):235–243
- Beekman AT, Copeland JR, Prince MJ (1999) Review of community prevalence of depression in later life. *Br J Psychiatry* 174:307–311
- Blay SL, Fillenbaum GG, Marinho V, Andreoli SB, Gastal FL (2011) Increased health burden associated with comorbid depression in older Brazilians with diabetes. *J Affect Disord* 134(1–3):77–84. doi:10.1016/j.jad.2011.05.012
- Blazer DG (2003) Depression in late life: review and commentary. *J Gerontol A* 58(3):249–265
- Braam AW, Prince MJA, Beekman TF, Delespaul P, Dewey ME, Geerlings SW et al (2005) Physical health and depressive symptoms in older Europeans. Results from EURODEP. *Br J Psychiatry* 187:35–42
- Buber I, Engelhardt H (2011) The association between age and depressive symptoms among older men and women in Europe. Findings from SHARE. *Comp Popul Stud* 36(1):103–126
- Byers AL, Vittinghoff E, Lui L, Hoang T, Blazer DG, Covinsky KE et al (2012) Twenty-year depressive trajectories among older women. *Arch Gen Psychiatry* 69(10):1073–1079
- Castro-Costa E, Dewey M, Stewart R, Banerjee S, Huppert F, Mendonca-Lima C et al (2007) Prevalence of depressive symptoms and syndromes in later life in ten European countries: the SHARE study. *Br J Psychiatry* 191:393–401
- Chang-Quan H, Zheng-Rong W, Yong-Hong L, Yi-Zhou X, Qing-Xiu L (2010) Education and risk for late life depression: a meta analysis of published literature. *Int J Psychiatry Med* 40(1):109–124
- Chiao C, Weng L, Botticello AL (2011) Social participation reduces depressive symptoms among older adults: an 18-year longitudinal analysis in Taiwan. *BMC Public Health* 11:292. doi:10.1186/1471-2458-11-292
- Cole MG, Dendukuri N (2003) Risk factors for depression among elderly community subjects: a systematic review and meta-analysis. *Am J Psychiatry* 160(6):1147–1156
- Cruwys T, Dingle GA, Haslam C, Haslam SA, Jetten J, Morton TA (2013) Social group memberships protect against future depression, alleviate depression symptoms and prevent depression relapse. *Soc Sci Med* 98:179–186. doi:10.1016/j.socscimed.2013.09.013
- Dewey ME, Prince MJ (2005) Mental Health. In: Börsch-Supan A, Jürges H (eds) *Health, Ageing and Retirement in Europe—First Results from the Survey of Health, Ageing and Retirement in Europe*. MEA Eigenverlag, Mannheim, pp 108–117
- Dines P, Hu W, Sajatovic M (2014) Depression in later-life: an overview of assessment and management. *Psychiatr Danub* 26:178–184
- Djernes JK (2006) Prevalence and predictors of depression in populations of elderly: a review. *Acta Psychiatr Scand* 113(5):372–387
- Duivis H, de Jonge P, Penninx BW, Na BY, Cohen BE, Whooley MA (2011) Depressive symptoms, health behaviors, and subsequent inflammation in patients with coronary heart disease: prospective findings from the heart and soul study. *Am J Psychiatry* 168(9):913–920
- Dunlop DD, Lyons JS, Manheim LM, Song J, Chang RW (2004) Arthritis and heart disease as risk factors for major depression: the role of functional limitation. *Med Care* 42:502–5011
- Gale CR, Aihie Sayer A, Cooper C, Dennison EM, Starr JM, Whalley LJ et al (2011) Factors associated with symptoms of anxiety and depression in five cohorts of community-based older people: the HALCYon (Healthy Ageing across the Life Course) Programme. *Psychol Med* 41(10):2057–2073
- Gaugler JE, Duval S, Anderson KA, Kane RL (2007) Predicting nursing home admission in the U.S: a meta-analysis. *BMC Geriatr* 7:13. doi:10.1186/1471-2318-7-13
- Geerlings SW, Beekman AT, Deeg DJ, van Tilburg W (2000) Physical health and the onset and persistence of depression in older adults: an eight-wave prospective community-based study. *Psychol Med* 30(2):369–380
- Glass TA, De Leon CM, Bassuk SS, Berkman LF (2006) Social engagement and depressive symptoms in late life: longitudinal findings. *J Aging Health* 18(4):604–628

- Han B, Jylha M (2006) Improvement in depressive symptoms and changes in self-rated health among community-dwelling disabled older adults. *Aging Ment Health* 10(6):599–605
- Hong S, Hasche L, Bowland S (2009) Structural relationships between social activities and longitudinal trajectories of depression among older adults. *Gerontologist* 49(1):1–11
- Huang J, Wong R, Chen C, Mao I, Huang C, Chang W et al (2011) Trajectory of depression symptoms and related factors in later life—a population based study. *J Affect Disord* 133(3):499–508
- Jang S, Cho S, Chang J, Boo K, Shin H, Lee H et al (2009a) Employment status and depressive symptoms in Koreans: results from a baseline survey of the Korean Longitudinal Study of Aging. *J Gerontol B* 64(5):677–683
- Jang S, Kawachi I, Chang J, Boo K, Shin H, Lee H et al (2009b) Marital status, gender, and depression: analysis of the baseline survey of the Korean Longitudinal Study of Ageing (KLoSA). *Soc Sci Med* 69(11):1608–1615
- Kaplan G, Glasser S, Murad H, Atamna A, Alpert G, Goldbourt et al (2010) Depression among Arabs and Jews in Israel: a population-based study. *Soc Psychiatry Psychiatr Epidemiol* 45(10):931–939
- Katz S, Downs TD, Cash HR, Grotz RC (1970) Progress in development of the index of ADL. *Gerontologist* 10(1):20–30
- Kessler RC, Berglund P, Demler O, Jin R, Koretz D, Merikangas KR, Rush AJ, Walters EE, Wang PS (2003) The epidemiology of major depressive disorder: results from the national comorbidity survey replication (NCS-R). *JAMA* 289(23):3095–3105
- Khalaila R, Litwin H (2014) Changes in health behaviors and their associations with depressive symptoms among Israelis aged 50 and older. *J Aging Health* 26(3):401–421
- Ku P, Fox KR, Chen L, Chou P (2012) Physical activity and depressive symptoms in older adults: 11-year follow-up. *Am J Prev Med* 42(4):355–362
- Lorant V, Deliège D, Eaton W, Robert A, Philippot P, Ansseau M (2003) Socioeconomic inequalities in depression: a meta-analysis. *Am J Epidemiol* 157(2):98–112
- Mechakra-Tahiri DS, Dube M, Zunzunegui MV, Preville M, Berbiche D, Brassard J (2013) Pattern of change of depressive disorder over a one year period among community dwelling older adults in Quebec. *Depress Res Treat*. doi:10.1155/2013/451708
- Melchior M, Chastang J, Head J, Goldberg M, Zins M, Nabi H et al (2013) Socioeconomic position predicts long-term depression trajectory: a 13-year follow-up of the GAZEL cohort study. *Mol Psychiatry* 18(1):112–121
- Miech AR, Shanahan MJ (2000) Socioeconomic status and depression over the life course. *JHSB* 41(2):162–176
- Miller ME, Rejeski WJ, Reboussin BA, Ten Have TR, Ettinger WH (2000) Physical activity, functional limitations, and disability in older adults. *J Am Geriatr Soc* 48(10):1264–1272
- Montagnier D, Dartigues JF, Rouillon F, Peres K, Falissard B, Onen F (2014) Aging and trajectories of depressive symptoms in community dwelling men and women. *Int J Geriatr Psychiatry* 29:720–729
- Na'amnih W, Muhsen K, Tarabeia J, Saabneh A, Green MS (2010) Trends in the gap in life expectancy between Arabs and Jews in Israel between 1975 and 2004. *Int J Epidemiol* 39:1324–1332
- Oakes JM, Rossi PH (2003) The measurement of SES in health research: current practice and steps toward a new approach. *Soc Sci Med* 56(4):769–784
- Okun BS, Friedlander D (2005) Educational stratification among Arabs and Jews in Israel: Historical disadvantage, discrimination, and opportunity. *Pop Stud-J Demogr* 59(2):163–180
- Paluska SA, Schwenk TL (2000) Physical activity and mental health: current concepts. *Sports Med* 29:167–180
- Paterson HD, Warburton DE (2010) Physical activity and functional limitations in older adults: a systematic review related to Canada's physical activity guidelines. *Int J Behav Nutr Phys Act* 7(11):38. doi:10.1186/1479-5868-7-38
- Penninx BW, Guralnik JM, Ferrucci L, Simonsick EM, Deeg DJ, Wallace RB (1998) Depressive symptoms and physical decline in community-dwelling older persons. *JAMA* 279(21):1720–1726
- Prince MJ, Reischies F, Beekman AT, Fuhrer R, Jonker C, Kivela SL et al (1999) Development of the EURO-D scale—a European, Union initiative to compare symptoms of depression in 14 European centres. *Br J Psychiatry* 174:330–338
- Schoevers RA, Beekman AT, Deeg DJ, Geerlings MI, Jonker C, Van Tilburg W (2000) Risk factors for depression in later life; results of a prospective community based study (AMSTEL). *J Affect Disord* 59(2):127–137
- Singh G, Jackson CA, Dobson A, Mishra GD (2014) Bidirectional association between weight change and depression in mid-aged women: a population—based longitudinal study. *Int J Obes* 38(4):591–596
- Strawbridge WJ, Deleger S, Roberts RE, Kaplan GA (2002) Physical activity reduces the risk of subsequent depression for older adults. *Am J Epidemiol* 156(4):328–334
- Sutin AR, Terracciano A, Milanese Y, An Y, Ferrucci L, Zonderman AB (2013) The trajectory of depressive symptoms across the adult life span. *JAMA Psychiatry* 70(8):803–811
- Taylor MG, Lynch SM (2004) Trajectories of decline, social support, and depressive symptoms in later life. *J Gerontol B* 59(4):S238–S246
- Teychenne M, Ball K, Salmon J (2008) Physical activity and likelihood of depression in adults: A review. *Prev Med* 46(5):397–411
- Walsemann KM, Gee GC, Geronimus AT (2009) Ethnic differences in trajectories of depressive symptoms: disadvantage in family background, high school experiences, and adult characteristics. *J Health Soc Behav* 50(1):82–98
- Wilkins CH, Mathews J, Sheline YI (2009) Late life depression with cognitive impairment: evaluation and treatment. *Clin Interv Aging* 4:51–57
- Yang Y (2007) Is old age depressing? Growth trajectories and cohort variations in late-life depression. *J Health Soc Behav* 48(1):16–32
- Yang Y, George LK (2005) Functional disability, disability transitions, and depressive symptoms in late life. *J Aging Health* 17:263–292