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Lifestyle factors and the course of depression in older adults: A NESDO study

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Objectives: To investigate whether lifestyle indicators including physical exercise, sleep duration, alcohol use, body mass index, smoking status, and a composite lifestyle index are associated with the depression course in older adults.

Methods: Data of 283 older adults were used from the Netherlands Study of Depression in Older Persons. Depressive disorders at baseline were assessed with the Composite International Diagnostic Interview. The depression course at 2-year follow-up was assessed with the Inventory of Depressive Symptoms (IDS, score 0–84) every 6 months; physical exercise with the International Physical Activity Questionnaire; alcohol use with the Alcohol Use Disorders Identification Test; body mass index by anthropometry; and sleep duration and smoking status by interview questions. A composite lifestyle index was calculated by summing scores assigned to each lifestyle factor, with a higher score indicating healthier behavior.

Results: Of all participants, 61.1% had chronic depression (all IDS scores 14–84), 20.1% had intermittent depression (1 IDS score \leq 14), and 18.7% remitted depression (last 2 IDS scores \leq 14). None of the investigated lifestyle indicators, nor the composite lifestyle index was associated with depression course, after adjustment for covariates.

Conclusions: Lifestyle factors do not predict the course of depression at 2-year follow-up in older adults.

KEYWORDS

depression, depression course, lifestyle, older adults

1 | INTRODUCTION

In 2015, 6.8% of the population aged 55 years and older in the United States had some type of mood disorder, most commonly a major depressive disorder.¹ Various studies have shown that late-life depression is more often chronic than depression in younger adults^{2,3} and leads to a higher risk of mortality⁴ and suicide compared with non-depressed older adults.^{5,6} These poor outcomes necessitate investigating the

determinants of the course of depression in older adults. According to a systematic review on the prognosis of depression in adults of 55 years and older, studies in the community showed that older age, functional limitations, external locus of control, somatic comorbidity, and baseline depression level were associated with persistence of depression.⁷ Cross-sectional studies have shown that lifestyle factors are associated with the occurrence of clinically diagnosed depression and depressive symptoms in older persons. Such associations have been described for

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physical exercise,⁸⁻¹⁰ sleep disturbance and sleep duration,^{11,12} alcohol consumption,^{13,14} body mass index (BMI),^{15,16} and smoking.^{15,17} However, lifestyle factors have only rarely been studied in longitudinal studies, in relation to the course or prognosis of depression.

A study on the impact of lifestyle factors on the course of depression and anxiety disorders in adults aged 18 to 65 found that low physical activity predicted the persistence of both depression and anxiety,¹⁸ and a longitudinal study in Koreans aged 65 and older found that above-moderate physical activity (more than 30 minutes of physical activity per day) reduced the risk of persistent late-life depression.⁸ Alcohol dependence was also found to be a risk factor for an unfavorable course of depression in adults aged 18 to 65.¹⁹ A retrospective cohort study on obesity and major depression in adults aged 20 through 59 found that obesity was associated with a more chronic course of depression.²⁰ Nicotine-dependent smokers aged 18 to 65 years recovered more slowly from depressive symptoms than never-smokers, former smokers, and non-dependent smokers.²¹ Both long and short sleep duration increases the risk of persistence of depressive symptoms in adults 18 to 65 years.²²

In this study, we aimed to investigate whether lifestyle indicators including physical exercise, sleep duration, alcohol use, BMI, smoking status, and a composite lifestyle index predicted the course of depression in older adults. Based on previous research, we expected an unhealthy lifestyle to be associated with a more unfavorable course of depression, and with still meeting diagnostic criteria for a depressive disorder 2 years later.

2 | METHODS

2.1 | Participants and procedure

The Netherlands Study of Depression in Older Persons (NESDO) is a prospective cohort study. A total of 378 clinically depressed and 132 non-depressed older adults (aged 60 years and older) were examined over the course of 2 years. Participants with a depressive disorder were recruited from general practitioners and 5 regional mental health care centers in the Netherlands.²³ Exclusion criteria were having another serious psychiatric disorder, suspected dementia according to the clinician, a Mini Mental State Examination (MMSE)-score²⁴ of <18 (out of 30) and inadequate understanding of the Dutch language. The recruitment and the assessment procedures of the NESDO study have been described in more detail elsewhere.²³ Baseline assessment included physical assessments, written questionnaires, and an interview. Written questionnaires were administered every 6 months throughout the 2 years of the study and face-to-face assessment took place 2 years after baseline.³ The study protocol of NESDO is in accordance with the Declaration of Helsinki and has been approved centrally by the Ethical Review Board of the VU University Medical Center and subsequently by the local ethical review boards of the participating centers. Written informed consent was obtained from all participants at the start of the baseline assessment.

Ninety-three depressed participants did not participate in the 2-year follow-up (28% deceased, 16% refusal, 13% unable due to physical reasons, 38% unable due to mental reasons, 5% no contact)³; another 2 had missing data on their course of depression. Thus, 95 participants were excluded from the current study. This resulted in 283 participants included in our study sample.

Key points

- Depression is often a chronic disorder in older persons
- Lifestyle factors do not seem to influence the course of depression in older adults.

3 | MATERIALS

3.1 | Depression

Major depressive disorder, minor depressive disorder, and dysthymia within the last 6 months were diagnosed at baseline and at 2-year follow-up using the Composite International Diagnostic Interview (World Health Organization version 2.1; lifetime version)²⁵ based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR)²⁶ criteria. The Composite International Diagnostic Interview is a standardized diagnostic clinical interview designed to assess mental disorders. It is considered to be a reliable and valid measure to assess depressive disorders.^{25,27}

Severity and the course of depression were measured using a self-report questionnaire: the Inventory of Depressive Symptoms (IDS).²⁸ The IDS is a 30-item self-report questionnaire that was designed to carefully assess all core diagnostic depressive symptoms.²⁹ The IDS has acceptable psychometric properties in depressed outpatients²⁸ as well as in depressed inpatients.³⁰ The IDS score ranges between 0 and 84, with a higher score indicating more severe depressive symptoms. The cutoff score for remission is 14.²⁹ The different types of depression courses were derived from Comijs et al. (2015)³ and include 3 course types:

- Remitted depression, where in at least the last 2 observations IDS ≤ 14 ;
- Intermittent depression, where at least in 1 of the observations IDS ≤ 14 ;
- Chronic depression, where all IDS scores were between 14 and 84.

3.2 | Lifestyle indicators

3.2.1 | Physical exercise

Physical exercise was measured using the Dutch short version of the International Physical Activity Questionnaire (IPAQ).³¹ The IPAQ is a self-report questionnaire used to assess physical activity levels and consists of 27 items.^{10,32,33} According to the Metabolic Equivalent of Task (MET)-minutes (see Ainsworth et al. (2000)³³ for details), participants were categorized in 1 of 3 categories derived from Patterson (2005)³²; High: at least 3000 MET-minutes/week, Moderate: at least 600 MET-minutes/week, Low: those who do not meet criteria for the categories High or Moderate. When participants had 1 missing value for 1 of the 3 activity items (vigorous activities, moderate activities, and walking activities), stratified mean scores were imputed. Stratification was based on sex and 5-year age stratum.

3.2.2 | Sleep duration

Sleep duration was measured using the question: "How many hours a night on average did you sleep during the past 4 weeks?". In order to investigate the effect of long or short versus "normal" sleep, we divided sleep duration into long (9 hours or more), normal (7 and 8 hours), and short (6 hours or less).

3.2.3 | Alcohol use

Alcohol use and the risk of alcohol use disorders were measured using the Alcohol Use Disorders Identification Test (AUDIT).³⁴ The AUDIT questionnaire consists of 10 items and ranges from 0 to 40. The AUDIT has proven to be a good instrument to assess at-risk drinking in community dwelling adults aged 65 to 74 years using a cut-off score of 5 (sensitivity: .86; specificity: .87).³⁵

Participants were categorized as non-drinkers (AUDIT score = 0), moderate drinkers (AUDIT scores 1–5), and at-risk drinkers (AUDIT score \geq 6). Even though no alcohol use has been associated with poorer health outcomes in older adults, in terms of health behavior, we consider not drinking healthier than drinking.

3.2.4 | Body mass index

Body mass index (BMI) was measured using anthropometry. Participants were categorized in 3 categories based on Bahat et al. (2012)³⁶ and An and Xiang (2015)¹⁵: normal weight (BMI 20–24.9), underweight (BMI \leq 19.9), and overweight (BMI \geq 25).

3.2.5 | Smoking

Smoking status was measured by interview. Participants were categorized into never smokers, past smokers, and current smokers.

3.2.6 | Composite lifestyle index

To calculate the overall composite lifestyle index, we assigned a score of 3 to the "healthiest" behavior for each variable, a score of 2 for "moderately healthy" behavior, and a score of 1 for the unhealthiest behavior. Because for sleep and BMI the associations with health outcomes such as depression are generally U-shaped, we assigned 3 points to the "normal sleep" and "normal weight" categories, and 2 and 1 points, respectively, for smaller and larger deviations of the "normal" categories. Table 1 shows the points assigned to each category of the lifestyle factors. All scores were summed up, resulting in a total composite lifestyle index (range 5 to 15). The highest possible composite lifestyle index score was obtained by participants with a

high activity level, having 7 to 8 hours of sleep, never drinking, having a BMI between 20 and 24.9, and never having smoked.

3.3 | Confounders

The confounders were chosen based on their known association with depression and lifestyle factors.⁷ The first was level of education and was measured using standard questions. Participants were categorized into basic, intermediate, or high level of education. The second was functional limitations measured using the World Health Organization –Disability Assessment Schedule (WHO-DAS).³⁷ The WHO-DAS is a 36-item questionnaire that examines difficulties in cognition, mobility, self-care, getting along, life activities, and participation. Because this study concerns old-age participants, the work-related items were omitted. This resulted in a total of 32 items and a range of 0 to 128. The third confounder was antidepressant drug use and was done by registration of medication participants used and a question about frequency of use. The fourth confounder was the number of chronic diseases which was measured using interview questions and was thus based on self-report. Participants were asked if they had COPD, a heart disease, cancer, and several other chronic diseases. The final confounder was cognitive status, measured with the MMSE.²⁴ The MMSE is an 11-item questionnaire that examines the cognitive status of patients and has a range of 0 to 30; participants with an MMSE score of $<$ 18 were excluded from the study (see exclusion criteria).

3.4 | Statistical analyses

Statistical analyses were done using the software program IBM SPSS Statistics 20 for Mac (Armonk, NY: IBM Corp, 2011). First, the characteristics of the depressed participants were summarized according to depression course type. Second, differences in characteristics between participants with a remitted, intermittent, and chronic depression course were assessed using 1-way ANOVAs for continuous variables and chi-squared (χ^2) tests for categorical variables. To investigate which groups differed significantly from each other in the ANOVA, a post hoc Hochberg GT2 test was used for variables with equal variances. Variables with no equal variances were analyzed using a post hoc Games-Howell test.

To investigate independent contributions of each lifestyle variable to the course of depression, the associations between determinants and the course of depression were investigated using 1 multivariate multinomial logistic regression model with all determinants and possible confounders as independent variables, and categories of course of depression as dependent variable.

TABLE 1 Composite lifestyle index scoring sheet

Lifestyle factor	Composite Lifestyle Index		
	3 (healthy)	2 (moderately healthy)	1 (unhealthy)
Physical exercise (IPAQ)	\geq 3000 MET-minutes/week	2999–600 MET-minutes/week	\leq 599 MET-minutes/week
Sleep duration	7 and 8 hours	6 or 9 hours	\leq 5 hours or \geq 10 hours
Alcohol use (AUDIT)	Score = 0	Score 1–5	Score \geq 6
Body mass index (BMI)	BMI 20–24.9	BMI 18.5–19.9 or BMI 25–29.9	BMI \leq 18.4 or BMI \geq 30
Smoking status	Never smokers	Past smokers	Current smokers

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; IPAQ, International Physical Activity Questionnaire.

Notes. The higher the composite lifestyle score, the healthier the behavior.

TABLE 2 Characteristics of the study population of depressed older adults (*N* = 283)

	Course of Depression			χ^2 (df) or <i>F</i> (df between; df within) ^a	<i>P</i> -Value	
	Total study population	Remitted depression (<i>n</i> = 53)	Intermittent depression (<i>n</i> = 57)			Chronic depression (<i>n</i> = 173)
Demographic characteristics						
Female gender, <i>n</i> (%)	186 (65.7%)	31 (58.5%)	37 (64.9%)	118 (68.2%)	$\chi^2 = 1.72$ (2)	.42
Age, years, mean (<i>SD</i>)	70.4 (7.2)	68.3 (6.3) ^b	71.8 (7.6) ^b	70.5 (7.3)	<i>F</i> = 3.32 (2; 282)	.04
Educational level						
Basic, <i>n</i> (%)	54 (19.1%)	5 (9.4%)	9 (15.8%)	40 (23.1%)	$\chi^2 = 7.69$ (4)	.10
Intermediate, <i>n</i> (%)	162 (57.2%)	38 (71.7%)	33 (57.9%)	91 (52.6%)		
High, <i>n</i> (%)	67 (23.7%)	10 (18.9%)	15 (26.3%)	42 (24.3%)		
Psychological variables						
DSM-IV diagnosis at baseline						
Minor depression, <i>n</i> (%)	10 (3.5%)	2 (3.8%)	4 (7.0%)	4 (2.3%)	$\chi^2 = 14.74$ (6)	.02
Major depression, <i>n</i> (%)	200 (70.7%)	44 (83.0%)	43 (75.4%)	113 (65.3%)		
Dysthymia, <i>n</i> (%)	5 (1.8%)	0 (0.0%)	2 (3.5%)	3 (1.7%)		
Double diagnosis, <i>n</i> (%)	68 (24.0%)	7 (13.2%)	8 (14.0%)	53 (30.6%)		
DSM-IV diagnosis at follow-up, <i>n</i> (%)	163 (57.6%)	15 (28.3%)	28 (49.1%)	120 (69.4%)	$\chi^2 = 30.12$ (2)	< .001
Severity of depressive symptoms, IDS score, mean (<i>SD</i>)	29.5 (12.9)	21.7 (13.1) ^c	20.8 (9.7) ^d	34.7 (10.9) ^{c,d}	<i>F</i> = 49.21 (2; 279)	< .001
Somatic and lifestyle variables						
Antidepressant use, <i>n</i> (%)	209 (73.9%)	45 (84.9%)	40 (70.2%)	124 (71.7%)	$\chi^2 = 4.18$ (2)	.12
Functional limitations, WHO-DAS score, mean (<i>SD</i>)	31.9 (15.7)	24.6 (14.4) ^e	25 (13.4) ^f	36.4 (15.2) ^{e,f}	<i>F</i> = 20.72 (2; 277)	< .001
Number of chronic diseases, mean (<i>SD</i>)	2.1 (1.5)	1.5 (1.3) ^g	1.9 (1.3)	2.4 (1.6) ^g	<i>F</i> = 9.26 (2; 281)	< .001
Cognitive status, MMSE score, mean (<i>SD</i>)	28.0 (1.7)	28.2 (1.5)	28.1 (1.4)	27.9 (1.8)	<i>F</i> = 0.73 (2; 281)	.48
Lifestyle factors						
Physical exercise, IPAQ score, mean (<i>SD</i>)	2604.7 (2518.1)	2479.7 (2062.8)	3065.1 (2895.0)	2498.6 (2513.3)	<i>F</i> = 0.95 (2; 235)	.39
Sleep duration, hours						
9 hours or more, <i>n</i> (%)	56 (19.8%)	9 (17.0%)	14 (24.6%)	33 (19.1%)	$\chi^2 = 10.99$ (4)	.03
7–8 hours, <i>n</i> (%)	112 (39.6%)	25 (47.2%)	29 (50.9%)	58 (33.5%)		
6 hours or less, <i>n</i> (%)	115 (40.6%)	19 (35.8%)	14 (24.6%)	82 (47.4%)		
Alcohol use, AUDIT score						
Non-drinker, <i>n</i> (%)	100 (35.5%)	16 (30.2%)	16 (28.1%)	68 (39.5%)	$\chi^2 = 3.70$ (4)	.45
Moderate drinker, <i>n</i> (%)	126 (44.7%)	24 (45.3%)	29 (50.9%)	73 (42.4%)		
At-risk drinker, <i>n</i> (%)	56 (19.9%)	13 (24.5%)	12 (21.1%)	31 (18.0%)		
BMI						
Underweight, <i>n</i> (%)	12 (4.3%)	2 (2.8%)	0 (0.0%)	10 (5.8%)	$\chi^2 = 13.50$ (4)	.01
Overweight, <i>n</i> (%)	158 (56.0%)	21 (39.6%)	31 (54.4%)	106 (61.6%)		
Normal weight, <i>n</i> (%)	112 (39.7%)	30 (56.6%)	26 (45.6%)	56 (32.6%)		

(Continues)

TABLE 2 (Continued)

	Course of Depression			P-Value
	Total study population	Remitted depression (n = 53)	Intermittent depression (n = 57)	
Smoking status				$\chi^2 = 6.91$ (4) .14
Never smoker, n (%)	89 (31.7%)	17 (32.7%)	17 (30.4%)	
Past smoker, n (%)	126 (44.8%)	29 (55.8%)	27 (48.2%)	
Current smoker, n (%)	66 (23.5%)	6 (11.5%)	12 (21.4%)	
Composite lifestyle index, mean (SD)	10.4 (1.7)	10.9 (1.8) ^h	10.6 (1.7)	
				$F = 3.78$ (2; 282) .02

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; BMI, body mass index; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, fourth edition; IDS, Inventory of Depressive Symptomatology; IPAQ, International Physical Activity Questionnaire; MDD, major depressive disorder; N, number of participants; SD, standard deviation; WHO-DAS, World Health Organization Disability Assessment Schedule.

^aP-value for categorical variables: Pearson's χ^2 test; for continuous variables: analysis of variance. Post-hoc analyses showed a significant difference between:

^bremitted and intermittent depression for age, $P = .03$;

^cremitted and chronic depression for depression severity score, $P < .001$;

^dintermittent and chronic depression for depression severity, $P < .001$;

^eremitted and chronic depression for functional limitations, $P < .001$;

^fintermittent and chronic depression for functional limitations, $P < .001$;

^gremitted and chronic depression for number of chronic diseases, $P < .001$;

^hremitted and chronic depression for composite lifestyle index, $P = .003$.

For the analysis of the individual determinants, the "healthiest" category was taken as the reference category. In a second multivariate multinomial logistic regression model, all possible confounders and the composite lifestyle index were entered as independent variables. Analyses were adjusted for the following potential confounders: age, sex, level of education, functional limitations, antidepressant drug use, severity of depression at baseline, number of chronic diseases, and cognitive status. The reference group for the dependent variable was the remitted depression group. Next, 2 binary logistic regression analyses were performed with "Diagnosis of depression at 2-year follow-up" versus remission at 2-year follow-up (reference category) as a dependent variable, and all independent variables and the composite lifestyle index as independent variables, respectively.

Missing values of the determinants were imputed with multiple imputations based on linear regression; all independent variables were used as predictor variables for the imputations. The following variables had missing values: physical exercise ($n = 45$), alcohol use ($n = 1$), BMI ($n = 1$), smoking status ($n = 2$), severity of depressive symptoms ($n = 1$), number of chronic diseases ($n = 1$), cognitive status ($n = 1$), and functional limitations ($n = 5$). A P -value of <0.05 was considered significant for all analyses.

4 | RESULTS

4.1 | Participant characteristics

Table 2 shows the characteristics of the total study population. Of the 283 depressed older adults, mean age was 70.3 (standard deviation, SD, ± 7.2 ; range 60–90). At 2-year follow-up, most participants showed a chronic course of depression (61.1%), whereas 20.1% had intermittent depression, and 18.7% were in remission. Of the total study population 44.2% still met diagnostic criteria for a depressive disorder at the 2-year follow-up, 3 of whom belonged to the "remitted depression" category according to the IDS criteria. Of the "chronic depression" group, 56 participants no longer met the criteria for a DSM-IV depressive disorder at 2-year follow-up. Those in remission were, on average, 3.5 years younger than the intermittent depression group. Furthermore, the chronic depression group had significantly more often a double diagnosis (major depression and dysthymia) at baseline compared with the remitted and intermittent depression groups. Participants in the chronic depression group reported more severe depressive symptoms and more functional limitations than the other 2 groups at baseline. In addition, those in the chronic depression group, on average, reported more chronic (somatic) diseases than those in the remitted depression group.

Physical exercise, alcohol use, and smoking status showed no differences between the 3 course groups. The chronic depression group reported short sleep duration (6 hours or less) significantly more often than the remitted and intermittent depression groups. Participants in the chronic depression group were more often overweight than participants in the remitted and intermittent depression groups. Post-hoc pairwise comparisons showed that the chronic depression group on average scored 0.7 points lower on the composite lifestyle index than the remitted depression group.

TABLE 3 Lifestyle variables as predictors of intermittent depression and chronic depression: Multivariate analysis (N = 283)

	Course of Depression					
	Intermittent depression (n = 57)			Chronic depression (n = 173)		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Covariates						
Age at baseline	1.10	1.03–1.18	.005	1.08	1.01–1.15	.02
Female gender	1.48	0.59–3.73	.40	1.16	0.51–2.65	.72
Functional limitations (WHO-DAS) score	1.02	0.98–1.07	.29	1.01	0.97–1.05	.67
Antidepressant use	0.39	0.13–1.13	.08	0.27	0.10–0.75	.01
Severity of depressive symptoms at baseline (IDS score)	0.99	0.93–1.04	.62	1.12	1.06–1.17	< .001
Educational level (ref: basic)						
Intermediate	0.55	0.15–1.99	.36	0.52	0.16–1.73	.29
High	1.23	0.28–5.42	.79	0.99	0.25–3.96	.99
Number of chronic diseases	1.17	0.83–1.65	.37	1.25	0.92–1.69	.16
Cognitive status (MMSE score)	1.02	0.76–1.38	.88	0.97	0.75–1.25	.78
Determinants						
Physical exercise (IPAQ score)	1.00	1.00–1.00	.21	1.00	1.00–1.00	.50
Sleep duration (ref: 7–8 hours)						
9 hours or more	1.57	0.51–4.84	.43	1.44	0.50–4.15	.50
6 hours or less	0.57	0.21–1.58	.28	0.68	0.28–1.65	.39
Alcohol use (ref: no drinker)						
Moderate drinker	1.37	0.51–3.66	.54	1.22	0.51–2.91	.66
At-risk drinker	0.93	0.27–3.26	.91	0.59	0.19–1.82	.36
BMI (ref: normal weight)						
Underweight	N/A ^a	N/A	N/A	0.83	0.12–5.55	.84
Overweight	1.54	0.64–3.73	.34	1.95	0.86–4.41	.11
Smoking status (ref: never smoker)						
Past smoker	0.80	0.30–2.18	.67	0.69	0.28–1.67	.41
Current smoker	1.96	0.49–7.78	.34	2.35	0.68–8.20	.18

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; BMI, Body Mass Index; CI, confidence interval; IDS, Inventory of Depressive Symptomatology; IPAQ, International Physical Activity Questionnaire; MMSE, Mini-Mental State Examination; WHO-DAS, World Health Organization Disability Assessment Schedule.

Notes. One multivariate multinomial logistic regression analysis was conducted. The reference category for the dependent variable is remitted depression. Significance test = Wald χ^2 , $df = 1$ for all analyses.

^aNo one in the intermittent group was underweight.

4.2 | The course of depression, lifestyle indicators, and the composite lifestyle score

A multinomial regression analysis of the effect of the individual lifestyle factors on the course of depression showed that participants in the intermittent depression and chronic depression groups were older than participants in the remitted depression group (Table 3). Participants in the chronic depression group had more severe depressive symptoms at baseline and were less likely to use antidepressant medication than the remitted depression group. None of the lifestyle factors were significantly associated with the course of late-life depression.

Multinomial regression analysis with the composite lifestyle index as independent variable showed no significant association with the course of depression (odds ratio (OR) = 0.98, 95% confidence interval (CI) 0.74–1.29, $P = .88$) for the intermittent depression group and (OR 0.92, 95% CI 0.69–1.23, $P = .58$) for the chronic depression group.

4.3 | Binary logistic regression and remission

Table 4 shows the results of a binary logistic regression analysis on the effect of the lifestyle indicators on having a diagnosis of a depressive disorder at 2-year follow-up (N = 256; of 27 persons no diagnosis at follow-up was available). Participants who had more severe depression at baseline and who did not use antidepressant medication were more likely to still have a depression diagnosis at follow-up, whereas none of the lifestyle factors appeared to be a predictor of this outcome. Again, the composite lifestyle index score was not significantly associated with still having a depression diagnosis at follow-up (OR = 0.84, 95% CI = 0.69–1.02, $P = .07$).

5 | DISCUSSION

In this longitudinal study of 283 depressed older adults, 61.1% of the patients showed a chronic course of depression during 2-year

TABLE 4 Lifestyle variables as predictors of having a depressive disorder at follow-up (N = 256)

	Depressive Disorder at Follow-up (n = 125)		
	Odds ratio	95% CI	P-value
Covariates			
Age at baseline	1.02	.98–1.07	.32
Female gender	.80	.44–1.47	.48
Functional limitations (WHO-DAS) score	1.01	.98–1.04	.60
Antidepressant use	.50	.26–.98	.04
Severity of depressive symptoms at baseline (IDS score)	1.05	1.02–1.09	.006
Educational level (ref: basic)			
Intermediate	.77	.31–1.91	.57
High	1.33	.49–3.62	.58
Number of chronic diseases	1.08	.98–1.04	.65
Cognitive status (MMSE score)	.86	.69–1.06	.16
Determinants			
Physical exercise (IPAQ score)	1.00	1.00–1.00	.38
Sleep duration (ref: 7–8 hours)			
9 hours or more	1.33	.57–3.09	.51
6 hours or less	1.05	.50–2.20	.90
Alcohol use (AUDIT) (ref: no drinker)			
Moderate drinker	1.48	.71–3.09	.30
At-risk drinker	.82	.31–2.18	.68
BMI (ref: normal weight)			
Underweight	.65	.17–2.55	.54
Overweight	1.13	.62–2.07	.69
Smoking status (ref: never smoker)			
Past smoker	.83	.43–1.63	.59
Current smoker	1.48	.66–3.33	.34

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; BMI, body mass index; CI, confidence interval; IDS, Inventory of Depressive Symptomatology; IPAQ, International Physical Activity Questionnaire; MMSE, Mini Mental State Examination; WHO-DAS, World Health Organization Disability Assessment Schedule.

Notes. One binary logistic regression analysis was conducted. The reference category for the dependent variable is not having a depressive disorder at follow-up.

follow-up, and 44.2% of the participants still had a diagnosis of depression 2 years later. None of the investigated lifestyle indicators predicted the course of depression at 2-year follow-up.

The finding that BMI did not predict the course of depression in older adults does not seem to be consistent with literature showing that being underweight, overweight, or obese increased the risk of having clinically relevant depressive symptoms at follow-up in older adults.^{38–40} However, it is possible that risk factors for developing depressive symptoms are different from risk factors for persistence of depressive symptoms. In addition, this discrepancy may be explained by the extensive adjustment for multiple confounders in our study.

Contrary to our hypothesis, physical exercise, sleep duration, alcohol use, and smoking status were not associated with the course of depression either. The discrepancy between our results and those of the study in Korean elderly, in which a protective effect of above-moderate physical activity was reported,⁸ may be due to the use of the IPAQ to measure physical activity in our study, because the IPAQ was found to significantly underestimate time spent in sitting and overestimate time spent on walking and vigorous activities in older adults.⁴¹ If overestimation of physical exercise occurred in our study and if it was also associated with depression severity, this non-random

misclassification could have resulted in not finding an association between physical exercise and depression course. Also, physical exercise “in the past week” may not be an accurate representation of physical exercise over a longer period.

Also sleep duration may have been misclassified, depending on depression severity, because depressive symptoms are associated with reporting shorter subjective sleep duration than sleep duration measured with actigraphy in older adults.⁴² With regard to alcohol consumption, we categorized our participants into non-drinkers, moderate drinkers, and at-risk drinkers; these categories did not predict the course of depression, even though a previous cross-sectional study in the same population showed that moderate drinkers had fewer depressive symptoms than abstainers or at-risk drinkers.¹³ In future studies, it would be worthwhile to investigate whether stopping or reducing alcohol use causes a change in the course of depression.

We found that smoking status did not predict the course of depression, which is not in line with previous research in younger adults that showed that dependent smokers recovered more slowly from depression and anxiety, even after adjustment for covariates.²¹ It is possible that the age difference between the 2 study populations plays a role in this discrepancy.

Lastly, the composite lifestyle index was not significantly associated with the course of depression, in contrast to our hypothesis. All lifestyle factors were converted into categorical variables, which may have resulted in a lack of statistical power. Somewhat similar studies^{43,44} also assigned scores to each lifestyle category, and they did find an effect of the composite lifestyle score.

5.1 | Strengths and limitations

The main strength of our study is the longitudinal design of the NESDO-study, which allowed assessment of the course of depression over a 2-year period. In addition, the study sample was recruited from different mental health care settings. Therefore, our sample can be considered representative for the depressed older adult population. The inclusion of many known potential confounders is also a strength.

Our study does have some limitations that need to be discussed. Firstly, this study uses mostly self-report measures, which may have resulted in socially desirable answers,⁴⁵ and in the previously mentioned potential misclassification of sleep duration⁴² and physical exercise.⁴¹ Secondly, even though the study design was longitudinal, causal inferences cannot be made, because that would require more than 2 assessments of both depression and of lifestyle factors.

6 | CONCLUSIONS

This study showed that none of the investigated lifestyle variables was associated with a chronic course of late-life depression after adjustment for confounders.

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