Prospective Changes in Healthy Lifestyle Among Midlife Women

When Psychological Symptoms Get in the Way

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Introduction: Anxiety and depression are linked to increased risk of cardiometabolic disease and mortality, and unhealthy behaviors may be the key mechanisms underlying these associations. Although higher levels of psychological symptoms are associated with individual unhealthy behaviors (e.g., physical activity, smoking), their roles in overall lifestyle remain understudied.

Methods: Midlife women (n=55,395) from the cohort Nurses' Health Study reported anxiety and depression symptoms in 1988 and 1992, respectively. Health behaviors (i.e., physical inactivity, BMI, diet, and alcohol and tobacco consumption) were measured in self-administered questionnaires in 1988 or 1992, and every 4 years until the last assessment available (2010; follow-up, 18–22 years). Data were analyzed in 2014–2015. Women were categorized according to initial level of psychological symptoms (e.g., lower versus higher anxiety symptoms).

Results: Despite slight improvements in healthy lifestyle over time among women with higher versus lower anxiety ($\beta_{interaction}$=0.002, 95% CI=0.001, 0.003), those experiencing more severe symptoms had a consistently less healthy lifestyle over time ($p<0.0001$). Each SD increase in anxiety symptoms was related to a decrease in healthy lifestyle score throughout follow-up (β_{pooled}=−0.09, 95% CI=−0.09, −0.08). Women with higher versus lower anxiety symptoms also had decreased odds of having a healthy lifestyle in 2010 (AOR=0.78, 95% CI=0.75, 0.81), particularly among women with an initially unhealthy lifestyle ($p_{interaction} \leq 0.0001$). Comparable patterns were observed with depression symptoms.

Conclusions: Among midlife women, anxiety and depression symptoms were associated with unhealthier lifestyle throughout follow-up and reduced odds of having a healthy lifestyle 20 years later. Treating psychological symptoms may promote healthier lifestyles.

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Introduction

Unfavorable habits like physical inactivity, unhealthy diet, and smoking are critical risk factors for cardiovascular diseases, diabetes, and cancer.[1–4] Anxiety and depression have also been linked with increased risk of cardiometabolic disease and mortality,[5,6] and various unhealthy behaviors have been proposed as potential mechanisms. Accordingly, biobehavioral theories have suggested psychological symptoms of anxiety and depression may be critical determinants of whether individuals engage in an integrated healthy lifestyle.[6,7] However, studies examining the influence of these symptoms on future adherence to a favorable lifestyle have been conducted primarily in patient populations (e.g., cardiac patients[8,9]). Thus, it is unclear if psychological symptoms influence adherence to an overall healthy lifestyle over time among adults without chronic illness.

Prospective studies have examined whether psychological symptoms increase future risk of single unfavorable behaviors among apparently healthy individuals.[10–18]

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For instance, in adults with initially low physical activity levels, higher anxiety and depression symptoms were related to 79% increased odds of being inactive 3 and 6 years later.[11] Other studies have demonstrated associations of anxiety and depression symptoms with subsequently developing excess adiposity and becoming obese[10,13,18] and with poor food choice, factors that may be used to cope with negative feelings.[19,20] A recent meta-analysis showed clinical anxiety disorders were related to a 40% increased risk of becoming a regular smoker,[14] while women with moderate versus low levels of psychological symptoms had fivefold increased odds of developing alcohol dependence problem over 18 months.[17]

Thus, anxiety and depression symptoms appear to be associated with increased risk of engaging in specific unhealthy behaviors later on, but less is known about their impact on lifestyle globally. Because behaviors tend to cluster[4,21] and have a multiplicative impact on mortality compared with each individual behavior,[22] the contribution of psychological symptoms to shaping lifestyle over time needs to be examined. This study investigated whether anxiety or depression symptoms lead to worsening lifestyle or reduce the odds of subsequently having a healthy lifestyle in midlife women, who generally report more psychological symptoms than men of similar age.[16,18,23] The authors hypothesized that higher levels of anxiety/depression symptoms would be associated with unhealthier lifestyle over time and a lower odds of adopting a healthy lifestyle 20 years later.

Methods

Participants

The Nurses' Health Study is an ongoing cohort comprised of 121,700 U.S. female married nurses, aged 30–55 years at study inception in 1976.[24] They have completed biennial questionnaires on lifestyle, medical history, and newly diagnosed medical conditions, with a high response rate of 90% since 1976.[25] The present study includes women who responded to questionnaires including an assessment of anxiety (1988) and depression (1992) symptoms (differences between included and excluded women in Appendix Table 1, available online).

Figure 1 describes the two samples used for the analyses with anxiety and depression, respectively. Briefly, participants reporting a major medical condition (i.e., cancer, diabetes, heart disease) or those missing data on anxiety or depression symptoms, health behaviors, and confounders at baseline were not eligible. In analyses estimating changes in lifestyle score over time, women with data for only one of the four (for depression symptom analyses) or five (for anxiety symptoms analyses) follow-up lifestyle assessments were excluded (analytic samples: $n_{anxiety}$=55,395, $n_{depression}$=51,979). Hence, women with lifestyle data on at least two follow-up assessments (74.17% to 96.37% across time points) were included in the models. In analyses evaluating the odds of a healthy lifestyle at follow-up, women missing data on lifestyle in 2010 were excluded (analytic samples: $n_{anxiety}$=41,125, $n_{depression}$=41,343). Differences between excluded and included women on baseline characteristics are detailed in Appendix Table 1 (available online). The study protocol was approved by the IRB of Brigham and Women's Hospital and the Harvard T.H. Chan School of Public Health.

Measures

Anxiety symptoms were assessed in 1988 using the validated Crown–Crisp index.[26] The eight items are scored as 0 for *never*, 1 for *sometimes*, or 2 for *always*, with a derived sum ranging from 0 (no anxiety) to 16 (high anxiety). Internal consistency reliability in this sample was acceptable (α=0.61). Anxiety symptoms were dichotomized into higher ($\geq$4) versus lower ($<$4) levels.[27]

Depression symptoms were measured in 1992 using the five-item Mental Health Index from the Medical Outcomes Study Short-Form 36 Health Status Survey.[28] All items, with responses ranging from 1 for *all the time* to 6 for *none of the time*, were summed and the total was scaled from 0 (high symptoms) to 100 (low symptoms). Internal consistency reliability was high (α=0.82). Following previous work,[29] the score was dichotomized, whereby $\leq$60 indicated high and $>$60 lower depression symptoms. Although not assessed at the same time, measures of both anxiety and depression symptoms were available in the two analytic samples (i.e., anxiety sample using 1988 baseline and depression sample using 1992 baseline). In each sample, the two measures were modestly correlated ($r_{anxiety\ sample}$=0.30 and $r_{depression\ sample}$=0.29).

Consistent with a lifestyle composite index used in previous studies and with available prevention cancer and cardiovascular guidelines,[4,30–34] the lifestyle score included five behavior-related factors: physical activity, diet, BMI, and alcohol and tobacco consumption. Individual behaviors, obtained via self-report in 1998 or 1992 and every 4 years (last time point available, 2010), were first dichotomized according to whether individuals met recommended guidelines or not (1/0). Component scores were then summed to create a healthy lifestyle score, ranging from 0 for "less healthy" to 5 for "most healthy." Healthy lifestyle was also dichotomized at endorsement of four or five healthy behaviors, as this score has been associated with an approximately 50% decreased risk of stroke in this cohort.[34]

Physical activity was assessed with a validated questionnaire.[35] A score of 1 was assigned when women reported $\geq$150 minutes per week of moderate to vigorous activity (e.g., brisk walking, running, bicycling). BMI was derived using women's self-reported initial height and updated weight. Previous work with the cohort has shown self-reported weight is highly correlated with weight measured by study staff (r=0.96).[36] Optimal weight was defined as BMI $\leq$25 (score of 1).

Dietary information was obtained from the 131-item Food Frequency Questionnaire, which has high reproducibility and validity when compared with 1-week diet records and biochemical markers.[37,38] This study's summary score encompasses the following components of the Alternative Healthy Eating Index, adapted from the U.S. Department of Agriculture Healthy Eating Index[39]: higher intakes of vegetables, fruit, nuts, soy, and cereal fiber; high ratio of chicken plus fish to red meat and polyunsaturated to saturated fat; low intake of trans fat; and multivitamin use of 5 years. The score for each dietary component ranges from 0 to 10 (optimal dietary behavior). Within this cohort, researchers have

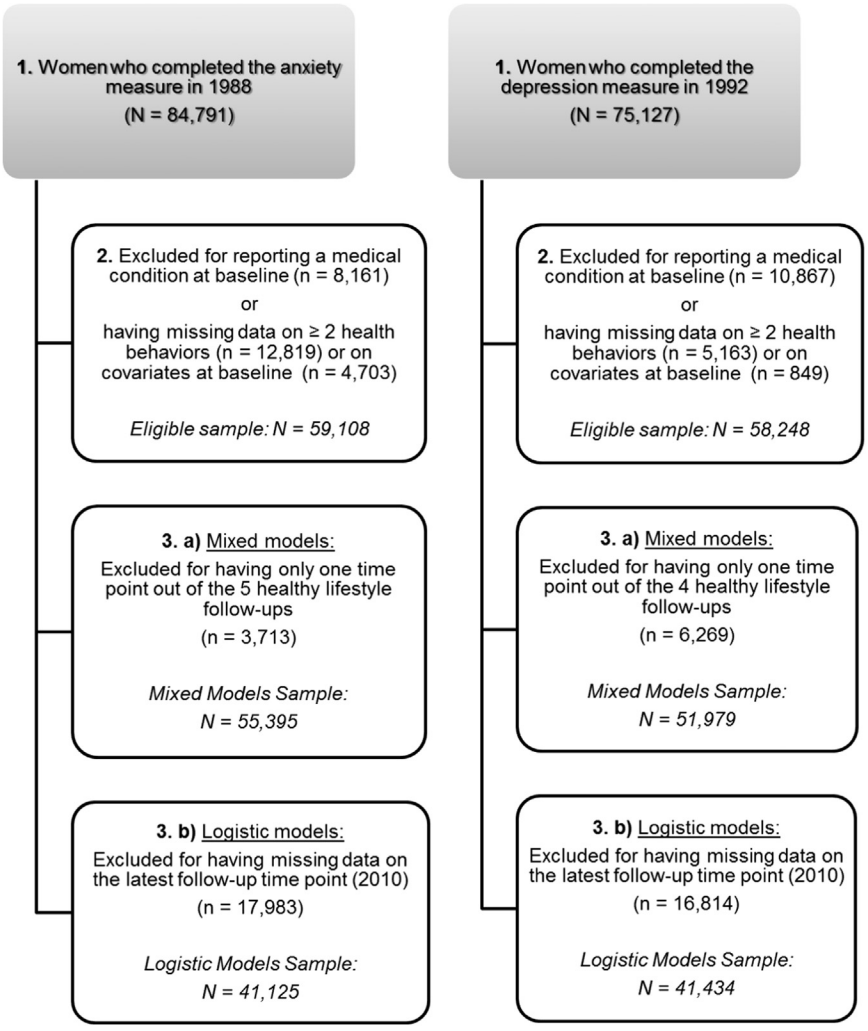

Figure 1. Flowchart of the different analytic samples.

used the highest 40% of the diet score distribution as a cut off,[34,40] a range that was strongly related to a lower risk for several diseases, including stroke, diabetes, and cancer.[41] Accordingly, a healthy diet (score of 1) was defined as a score in the top 40% of the current cohort distribution, updated at each time point. Healthy alcohol consumption (score of 1) was defined as drinking one drink or fewer per day.[42,43] Finally, women received a score of 1 if they reported being a non-current smoker. Scores were updated at each 4-year assessment.

Selected potential confounders included age (continuous), education level (registered nurses, bachelor, master, doctorate), and physical exam in the last 2 years (yes/no), as prior work has found receiving advice from a clinician is associated with weight loss, physical activity, and dietary changes.[44] Age and physical exam were self-reported at study baseline (anxiety analyses, 1988; depression analyses, 1992). Education was reported in 1992.

Statistical Analysis

Initial sets of analyses used linear mixed models for repeated measures to evaluate changes over time in lifestyle. These models use maximum likelihood estimate techniques that are robust to incomplete data on repeated measures.[45,46] For analyses considering anxiety, in the first model, anxiety symptoms were included as a continuous measure (standardized) along with a time variable (continuous measure in years). This model estimated change in lifestyle associated with each 1-SD change in anxiety symptoms and each additional year across the follow-up period. The second model used a dichotomous anxiety measure and estimated whether the lifestyle score differed significantly comparing women with lower versus higher anxiety symptoms. Both models included an interaction term to test whether the rate of change in lifestyle score depended on level of anxiety (e.g., decreased more rapidly among women with higher versus lower symptoms). Further analyses evaluated the main effect of anxiety symptoms on healthy lifestyle by pooling lifestyle scores across time points after taking into account any interaction effect. Stratified analyses tested whether associations between anxiety symptoms and subsequent lifestyle scores differed depending on initial lifestyle status (healthy/unhealthy). Analogous models were conducted using depression symptoms.

The association of baseline levels of psychological symptoms (measured continuously [standardized] and categorically [lower

versus higher anxiety/depression symptoms]) with the odds of reporting a healthy lifestyle at the end of follow-up was estimated with logistic regression models. A healthy lifestyle was defined as endorsing four or more healthy behaviors at the end of follow-up, otherwise (three or fewer healthy behaviors) categorized as unhealthy. Sensitivity analyses stratified logistic regression models by baseline lifestyle score (healthy/unhealthy).

Because unhealthy participants might be more likely to drop out of the study, inverse probability weights were developed and included in the models.[47] Specifically, the probability of participating at each time point was modeled based on the exposure and confounders of interest among participants who were included at baseline, and then a weight that corresponded to the inverse probability of participating was created. As results from age-adjusted models were similar to models, including age, education level, and physical exam, only fully adjusted results are presented. Analyses were conducted in 2014–2015 using SAS, version 9.3 with a 5% level of significance.

Results

At the 1988 baseline (for the anxiety analysis; 22 years of follow-up), women were aged 54.07 (SD=7.07; range, 41–69) years on average; most were registered nurses (69.1%) and reported a recent physical exam (82.4%). The majority reported low alcohol consumption (88.1%), were non-smokers (83.2%), and had a healthy BMI (56.7%). One third engaged in moderate to vigorous physical activity (34.5%) and reported high anxiety levels at baseline (35.0%). Distribution of characteristics was similar at the 1992 baseline (for the depression analysis; mean age, 57.61 years; registered nurse degree, 68.8%; physical exam, 87.9%; low alcohol consumption, 87.5%; non-smoker, 87.4%; healthy BMI, 51.4%; moderate to vigorous level of physical activity, 41.2%; 18 years of follow-up), although high depression symptom levels occurred in 15.3% of women only. Table 1 presents the distribution of confounders and health behaviors across baseline anxiety and depression symptom levels.

Both anxiety models suggested a small but significant interaction effect, although not in the expected direction (Table 2). For instance, Model 2 revealed that the rate of change in mean lifestyle score significantly differed over time, with more lifestyle improvement for the women with higher versus lower anxiety symptoms ($\beta_{interaction}$=0.002, 95% CI=0.001, 0.003). This small improvement associated with more anxiety symptoms appeared mainly among women who had unhealthy lifestyle at baseline (Appendix Table 2, available online). For these women, stratified analyses revealed a main effect of time such that lifestyle improved slightly over follow-up (β_{time}=0.005, 95% CI=0.004, 0.006); however, it is important to note they never achieved a healthy lifestyle, adopting fewer than three healthy behaviors throughout follow-up. By contrast, in women with healthy lifestyle at baseline, lifestyle score worsened over follow-up (β_{time}=−0.02, 95% CI=−0.02,−0.02). In these stratified analyses, higher versus lower anxiety symptoms were associated with similar decreases in lifestyle scores in women with healthy or unhealthy lifestyle at the outset ($\beta_{higher\ anxiety\ symptoms/healthy}$=−0.09, 95% CI=−0.11, −0.07; $\beta_{higher\ anxiety\ symptoms/unhealthy}$=−0.09, 95% CI=−0.10, −0.07). When considering anxiety effects in the full sample and after controlling for the interaction effect, mean healthy lifestyle scores of women with higher anxiety symptoms remained lower than those of women with lower anxiety symptoms throughout follow-up (pooled lifestyle score, lower symptoms=3.22 versus higher symptoms=3.07; $p<0.0001$); similarly, each 1-SD increase in anxiety symptoms was associated with a significant decrease in lifestyle score (β_{pooled}=−0.09, 95% CI=−0.09, −0.08).

Although the time effects were null, the interaction of depression symptoms with time was modestly but significantly associated with lifestyle score in both models. For example, in Model 4, the lifestyle score reported by women with higher versus lower symptoms improved slightly over time ($\beta_{interaction}$=0.003, 95% CI=0.001, 0.005), but this was primarily evident among women with initially unhealthy lifestyle scores (Appendix Table 2, available online). As observed in anxiety models, when stratified by initial lifestyle score, effects of time on lifestyle score were in the opposite direction ($\beta_{time\ among\ healthy}$=−0.02, 95% CI=−0.02, −0.02; $\beta_{time\ among\ unhealthy}$=0.01, 95% CI=0.01, 0.01). Nonetheless, the effect of depression symptoms on lifestyle was similar across strata ($\beta_{higher\ depression\ symptoms/healthy}$=−0.07, 95% CI=−0.10, −0.04; $\beta_{higher\ depression\ symptoms/unhealthy}$=−0.05, 95% CI=−0.07, −0.03). When considering depression effects in the full sample, after accounting for any interaction effect, unhealthier lifestyle was associated with higher versus lower depression symptoms levels (pooled lifestyle score, lower symptoms=3.18 versus higher symptoms=3.05; $p<0.0001$); similarly, lifestyle worsened over time with each 1-SD increase in depression symptoms (β_{pooled}=−0.07, 95% CI=−0.07, −0.06).

Every SD increase in anxiety symptoms was associated with 13% reduced odds (OR=0.87, 95% CI=0.85, 0.88) of reporting a healthy lifestyle in 2010 (Table 3). Likewise, women with higher versus lower symptoms had 22% reduced odds (OR=0.78, 95% CI=0.75, 0.81) of endorsing a healthy lifestyle in this period. In analyses stratified according to initial lifestyle score (healthy/unhealthy), higher levels of anxiety symptoms had a negative impact on future healthy lifestyle for women with initially healthy lifestyle (OR=0.87, 95% CI=0.82, 0.93), and even more

Table 1. Distribution of Confounders and Health Behaviors According to Baseline Anxiety (1988) and Depression (1992) Symptoms

	Anxiety symptoms				Depression symptoms			
	Healthy		Unhealthy		Healthy		Unhealthy	
Variable	Lower symptoms (*n*=13,579)	Higher symptoms (*n*=5,901)	Lower symptoms (*n*=22,458)	Higher symptoms (*n*=13,457)	Lower symptoms (*n*=16,500)	Higher symptoms (*n*=2,298)	Lower symptoms (*n*=27,512)	Higher symptoms (*n*=5,669)
Age, years, M (SD)	54.62 (7.07)	54.90 (7.08)	53.69 (7.04)	53.80 (7.04)	58.35 (7.03)	57.02 (7.06)	57.54 (6.93)	56.02 (6.82)
Education level								
Registered nurse	8,421 (62.01)	4,186 (70.94)	15,295 (68.10)	10,360 (76.99)	10,613 (64.32)	1,475 (64.19)	19,589 (71.20)	4,102 (72.36)
Bachelors	3,279 (24.15)	1,160 (19.66)	4,680 (20.84)	2,246 (16.69)	3,788 (22.96)	566 (24.63)	5,376 (19.54)	1,109 (19.56)
Masters	1,657 (12.20)	510 (8.64)	2,232 (9.94)	787 (5.85)	1,866 (11.31)	229 (9.97)	2,343 (8.52)	420 (7.41)
Doctorate	222 (1.63)	45 (0.76)	251 (1.12)	64 (0.48)	233 (1.41)	28 (1.22)	204 (0.74)	38 (0.67)
Had physical exam in the last 2 years	11,446 (84.29)	5,016 (85.00)	18,177 (80.94)	10,984 (81.62)	14,669 (88.90)	2,076 (90.34)	24,002 (87.24)	4,959 (87.48)
Health behaviors								
Healthy diet (top 40%)	10,194 (75.07)	4,407 (74.68)	4,870 (21.68)	2,723 (20.23)	12,221 (74.01)	1,656 (72.06)	5,836 (21.21)	1,108 (19.54)
Healthy alcohol consumption ($\leq$1 drink/day)	12,912 (95.09)	5,648 (95.71)	18,806 (83.74)	11,416 (85.17)	15,571 (94.37)	2,182 (94.95)	22,899 (83.23)	4,852 (85.59)
Healthy smoking status (non-smoker currently)	13,052 (96.32)	5,711 (96.90)	17,213 (76.76)	10,055 (74.81)	16,053 (97.44)	2,222 (96.90)	22,654 (82.45)	4,428 (78.22)
Healthy level of physical activity ($\geq$150 min/week)	9,136 (73.93)	3,681 (71.05)	3,363 (15.59)	1,768 (13.72)	12,400 (79.02)	1,595 (74.88)	5,799 (21.49)	932 (16.75)
Healthy BMI ($\leq$25)	10,581 (84.37)	4,502 (83.08)	9,326 (43.56)	5,208 (40.61)	12,418 (81.14)	1,743 (82.84)	9,189 (34.71)	1,989 (36.68)

Note: n (%), unless otherwise noted. Percentages refer to the row percentage of individuals within each psychological symptoms/lifestyle category with that characteristic.

Table 2. Linear Mixed Models With Baseline Anxiety (1988) and Depression (1992) Symptoms, Predicting Evolution of the Mean Continuous Lifestyle Score Between 1994 or 1998 and 2010

Exposures	Estimate, β (95% CI)
Anxiety (*n*=55,395)	
Model 1	
Anxiety symptoms (per 1 SD change)	**−0.11****** (−0.12, −0.10)
Time (years)	**−0.003****** (−0.004, −0.003)
Interaction (anxiety symptoms X time)	**0.001****** (0.001, 0.002)
Model 2	
Higher vs lower anxiety symptoms	**−0.18****** (−0.20, −0.16)
Time (years)	**−0.004****** (−0.005, −0.003)
Interaction (anxiety symptoms level X time)	**0.002***** (0.001, 0.003)
Depression (*n*=51,979)	
Model 3	
Depression symptoms (per 1 SD change)	**−0.08****** (−0.07, −0.07)
Time (years)	0.0001 (−0.001, 0.001)
Interaction (depression symptoms X time)	**0.002****** (0.001, 0.002)
Model 4	
Higher vs lower depression symptoms	**−0.17****** (−0.20, −0.14)
Time (years)	−0.001 (−0.001, 0.0003)
Interaction (depression symptoms level X time)	**0.003**** (0.001, 0.005)

Note: Boldface indicates statistical significance ($^{**}p \leq 0.01$; $^{***}p \leq 0.001$; $^{****}p \leq 0.0001$). To ease interpretation, the depression score was reversed (0=no depressive symptoms, 100=highest depressive symptoms) and then standardized. Because results from age-adjusted models were similar to models including age, education level. and physical exam, only fully adjusted results are presented.

strongly for women with initially unhealthy lifestyle (OR=0.82, 95% CI=0.78, 0.86, $p_{interaction} \leq 0.0001$).

Similarly, there was 12% decreased odds of reporting a healthy lifestyle at the end of follow-up for every SD increase in depression symptoms (OR=0.88, 95% CI=0.87, 0.90). Likewise, women with higher versus lower symptoms had 21% reduced odds (OR=0.79, 95% CI=0.75, 0.83) of having a healthy lifestyle in 2010. Moreover, higher versus lower levels of depression symptoms negatively impacted future healthy lifestyle, especially among women with initially unhealthy lifestyle scores ($OR_{healthy}$=0.91, 95% CI=0.83, 0.99; $OR_{unhealthy}$=0.86, 95% CI=0.81, 0.92; $p_{interaction} \leq 0.0001$).

Discussion

This research investigated whether anxiety or depression symptoms influence lifestyle over time and the odds of having a healthy lifestyle during adulthood. Consistent with prior work on individual health behaviors,[11,13,48,49] results adjusting for relevant confounders indicated that every SD increase in anxiety or depression symptoms was associated with a significant decrease in the healthy lifestyle score over 20 years and with 12%−13% reduced odds of endorsing a healthy lifestyle at the end of follow-up, suggesting that even less severe symptoms may alter behaviors. Furthermore, women with higher versus lower levels of symptoms had a sustained unhealthier lifestyle score across time points and 21%−22% lower odds of reporting a healthy lifestyle 20 years later. It is particularly noteworthy that this effect was independent of levels of healthy lifestyle at study inception. Regardless of lifestyle score at the outset, women with higher versus lower psychological symptom levels had lower lifestyle scores throughout follow-up and lower odds of having a healthy lifestyle 20 years later.

The decreases in the healthy lifestyle score evident in relation to psychological symptoms are meaningful for health. For example, an unadjusted 0.13- to 0.18-point decrease in the mean healthy lifestyle score was observed among women reporting higher levels of anxiety/depression symptoms at any given point in time (Appendix Discussion, available online). These decreases translate into a 2.1%−2.9% increased risk of stroke among women with higher versus lower levels of psychological symptoms, according to a study conducted among the same cohort where an average of 16.2% increased risk of stroke was obtained for each 1-point decrease on the healthy lifestyle score (Appendix Discussion, available online).[34] This adds to initial risk already incurred, and may be a conservative estimate, given that this study assessed additional risk starting when women were already at midlife.

Somewhat surprisingly, there was a non-significant effect of time on lifestyle when considering depressive symptoms. This might be related to the shorter follow-up period for this sample. Stratified analyses also provided some insight. Effects of time on lifestyle score among those with initially healthy versus unhealthy lifestyle were in the

Table 3. Logistic Regressions Models Evaluating the Association of Baseline Anxiety (1988) and Depression (1992) Symptoms With the Odds of Having a Healthy Lifestyle in 2010

	Main models			
	Anxiety		Depression	
Variable	Continuous (1 SD)	Dichotomized (higher vs lower symptoms)	Continuous (1 SD)	Dichotomized (higher vs lower symptoms)
Sample size, *n*	41,125	41,125	41,434	41,434
Women with healthy lifestyle at follow-up, *n*	13,433	13,433	13,692	13,692
OR (95% CI)	**0.87****** (0.85, 0.88)	**0.78****** (0.75, 0.81)	**0.88****** (0.87, 0.90)	**0.79****** (0.75, 0.83)
	Stratified analyses			
	Anxiety		Depression	
Variable	Healthy (higher vs lower symptoms)	Unhealthy (higher vs lower symptoms)	Healthy (higher vs lower symptoms)	Unhealthy (higher vs lower symptoms)
Sample size	14,865	26,260	15,315	26,119
Women with healthy lifestyle at follow-up, *n*	7,641	5,792	8,181	5,511
OR (95% CI)	**0.87****** (0.82, 0.93)	**0.82****** (0.78, 0.86)	**0.91*** (0.83, 0.99)	**0.86****** (0.81, 0.92)

Note: Boldface indicates statistical significance ($^{*}p \leq 0.05$; $^{****}p \leq 0.0001$). To ease interpretation, the depression score was reversed (0=no depressive symptoms, 100=highest depressive symptoms) and then standardized. Because results from age-adjusted models were similar to models including age, education level and physical exam, only fully adjusted results are presented. An OR <1 reflects lower odds of adopting a healthy lifestyle at the 2010 follow-up time assessment.

opposite direction and of similar magnitude, which could result in a null finding in the overall model. Unexpectedly, mixed models showed a slight tendency to adopt a healthier lifestyle over time among women with higher versus lower levels of psychological symptoms. Specifically, the number of cigarettes and drinks per day decreased over time, as other authors have also noted.[50] This could reflect some efficiency from public health policies in recent years or stem from methodologic issues, like "regression toward the mean" for the more anxious/depressed women or "ceiling effect" for the less anxious/depressed women. However, it was the women with both more severe anxiety/depression symptoms and unhealthy lifestyles at baseline who mainly drove this unexpected result; despite some improvements, these women generally maintained fewer than three healthy behaviors throughout follow-up. Finally, although this study found relatively small changes or differences between groups, these associations are similar in magnitude and direction to those found in other studies examining psychological states in relation to health behavior changes over time.[51–53] Moreover, as noted, prior work suggests that even small changes in behaviors are of clinical relevance and can impact health.

Limitations

Findings are from a sample of midlife women free of chronic illnesses at baseline, and cannot be generalized to other populations. Subjective reports of health behaviors may be vulnerable to social desirability bias, which can lead to overestimation of activity level and underestimation of consumed calories.[54,55] However, even if absolute levels are not reported completely accurately, behaviors would likely still be categorized appropriately as either healthy or unhealthy. Likewise, anxiety or depression symptoms might affect health behavior reports; however, women were not aware that these factors would be considered together. Strengths include the use of a prospective design over 20 years. The composite healthy lifestyle score also facilitates a comprehensive perspective on how anxiety and depression symptoms influence multiple behaviors that jointly matter for health.

Conclusions

Together, these results suggest that psychological symptoms influence subsequent lifestyle changes. Anxiety and depression levels indeed affected maintenance (or not) of health behaviors over time and the odds of having a future favorable lifestyle, even in a healthy population and regardless of initial behaviors. Though it may not be surprising that feeling more anxious or depressed impedes attaining or maintaining favorable habits, it is noteworthy that psychological symptoms can also lead to worse lifestyle over time in women with initially healthy lifestyles. Hence, screening for psychological symptoms

may be an effective primary prevention strategy, even when subclinical levels of symptoms or healthy habits are reported, enabling identification of middle-aged women who are at risk not only for common mental disorders but also for subsequently developing adverse physical health outcomes. Interestingly, some components of evidence-based treatments for anxiety/depression are directly related to lifestyle (e.g., increasing physical activity in cognitive behavioral therapy).[56] Thus, if confirmed by future clinical studies, implementing such treatments for psychological symptoms might be of particular interest.

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Author's contributions: study concept and design, CTF, SST, EMP, and LDK; interpretation of data, all authors; drafting of the manuscript, CTF and LDK; critical revision of the manuscript for important intellectual content, all authors; administrative support, SST; statistical analysis, CTF, EMP, and LDK.

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Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.1016/j.amepre.2016.04.021.