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Allostatic load score and lifestyle factors in the SWAN cohort: A longitudinal analysis

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ABSTRACT

Objectives: Allostatic load (AL) has been used to assess chronic stress. Previous studies have assessed associations between lifestyle factors and the AL. However, those studies have yet to evaluate associations longitudinally. Thus, the effect of lifestyle factors on the AL changes over time remains to be determined.
Study design: A longitudinal analysis was designed.
Methods: Our study included 1976 women identified from the Study of Women's Health Across the Nation (SWAN) who had completed at least seven waves of measurements since baseline. The Poisson mixed effects model was used to model AL and to assess how lifestyle factors affected AL over time.
Results: At baseline, the mean AL score was 2.44 (range 0–11). On average, the AL score increased by 3 % (ORs = 1.03, 95 % CI [1.01, 1.05]) per wave over time. For lifestyle factors, women who smoked cigarettes over time had higher AL than those who never smoked. On the other hand, women who ever drank alcohol at baseline, had leisure physical activity over time, and had at least average sleep quality at baseline, and had lower AL than their counterparts. We also identified a statistically significant interaction between alcohol drinking and time ($P < 0.01$). Furthermore, we generated a healthy score using the four lifestyle factors above to assess the potential accumulative effect of lifestyle factors on AL. We found that the AL increased by 16 % for each additional unhealthy lifestyle factor (ORs = 1.16, 95%CI: 1.12, 1.2).
Conclusions: This study demonstrates that lifestyle factors can influence the increase of AL over time.

1. Introduction

Stress is the most common part of life, and it is inevitable. Chronic stress has been thought to be linked to multiple chronic disease incidences and progressions, including hypertension, heart disease, obesity and metabolic syndrome, Alzheimer's disease, and cancer [1–5]. Allostatic load (AL) score, a novel complex index involving cumulative physiological toll across multiple systems, has been used to assess chronic stress levels [6–8]. As a result, AL can be used as an early warning indicator of risk for various diseases. Studies have shown that a high AL score is associated with obesity, hypertension, heart diabetes, and arthritis [9–11]. Moreover, we recently found that women with a higher AL have an increased risk of overall cancer [12].

Recent studies have shown that healthy behaviors can modify AL [13,14]. Sarah et al. reported that physical activity could reduce AL, and low to moderate alcohol use was beneficial for lower AL [15]. This is consistent with our previous findings that women who smoked, had no recreational physical activity, and had disturbed sleep were more likely than their peers to have a higher AL [12,15,16]. However, the nature of cross-sectional study designs limited those findings, and longitudinal associations between allostatic load and lifestyle factors have yet to be established. For example, we don't know how alcohol consumption may influence the AL growth trend. Answers to those questions are critical because they will lay a foundation for future healthy behavior-based interventions to reduce chronic stress and improve overall health.

To fill the gap, in this study, we attempted to assess how lifestyle factors (e.g., cigarette smoking, alcohol consumption, leisure physical activity, and sleep) may modify levels of AL in women over time, using the data from seven waves of the Study of Women's Health Across the Nation (SWAN, from 1996 to 2003), a community-based multisite prospective study.

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2. Methods

Data resource The study population was obtained from the (SWAN) study, which has been extensively described previously [17]. In brief, women were recruited from seven sites in the US. The eligibility criteria include 1) aged 42–52 years; 2) having an intact uterus and at least one ovary; 3) not using exogenous hormone preparations affecting ovarian function within one month before the baseline interview, and no hormone use within the three months before study screening; 4) had at least one menstrual period in the last three months. Women recruited into the baseline assessment during 1996–1997 (N = 3302) were followed up with ten waves. In this study, Due to missing blood biochemistry markers in the last three waves (SWAN, from 2004 to 2006), we used the data from the first seven waves. Furthermore, we excluded women with missing information essential for the AL score construction in each wave (N = 1326). Thus, the final analysis included a total of 1976 women with 13,832 observations.

AL Score This study used multiple factors to construct the AL score. The detailed methods were described previously by Zhao and Chyu et al. [12,16,18–21] Those factors comprise systolic blood pressure (SBP), diastolic blood pressure (DBP), C-reactive protein (CRP), high-lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), waist to hip ratio, body mass index (BMI), fasting serum glucose (FPG), triglycerides (TG), and resting heart rate (RHR). Moreover, we also included the medication history for treating metabolic diseases, stroke, heart disease, and hypertension as the medication factor. This study categorized each selected factor as 1 or 0 based on the risk threshold. The choice of risk threshold was determined according to clinical guidelines, as shown in Supplement Table 1. The AL score was accumulated by all selected factors, ranging from 0 to 11, and measured at each time point. Higher scores represented higher levels of chronic stress.

Key covariates: The study defined lifestyle factors as health-related behaviors, including smoking, alcohol consumption, sleep quality, and physical activity. Women who smoked at least 20 packs of cigarettes in their lives or at least one cigarette per day were defined as ever smokers. Over 85 % of women in this study reported they served alcohol less than once per week. So, women who drank at least one alcoholic drink per month were defined as ever drinkers. Women's sleep quality was estimated by how night sleep was during the past two weeks. Night's sleep was categorized as “Sound and restful”, “Average”, and “Restless”. Women's leisure physical activity was estimated by how often they played sports/exercise during the past year. Participants reported that more than one time per month was accounted as having leisure physical activity. Alcohol drinking and sleep quality were estimated in the baseline, while smoking and physical activity were estimated as dynamic in each wave. Thus, in this study, for alcohol drinking and sleep quality, we only used baseline data. Meanwhile, we used data from all seven waves for cigarette smoking and physical activity. Moreover, socioeconomic status (SES) variables included education and income. Education was assessed in the baseline and categorized as “High school or less than high school”, “Some college”, “College graduate”, and “Postgraduate”. Annual house income was assessed by all sources within their household in the last year and will be categorized as “less than 20000”, “20k ~50k”, “50K–100K”, and “over 100K”. Like smoking and physical activity, income was also estimated as dynamic in each wave.

Healthy-Score To assess the joint effect of unhealthy behaviors on AL overtime, we generated a Healthy-Score. Healthy-Score was accumulated by all healthy behaviors at baseline, including cigarette smoking (never vs. ever), alcohol drinking (never vs. ever), sleeping quality (average/sound and restful vs. restless), and physical activity (yes vs. no). Therefore, the range of Healthy-Score was from 0 to 4. A higher score indicated a woman with more unhealthy behaviors.

Statistical analysis Descriptive statistics were performed for each demographic, lifestyle, and socioeconomic factors. Univariate distributions of AL at baseline were calculated, and the mean AL scores across all waves were plotted by line. The Poisson mixed effect model was used to identify the longitudinal effect of lifestyle factors on AL. In this model, a random intercept was added that allows for random variation in each individual's baseline AL value and accounts for within-individual correlations in follow-up interviews. After that, a random slope was added to allow each group of lines to have a different slope, which makes the explanatory variable have a different effect on each group. The model equation is shown here:

$$logE\backslash\left(Y_{ij}\right) = B_{0i} + B_{Wi}Waves_{ij} + B_{Vi}Waves.Variated_{ij} + \varepsilon_{it}, \varepsilon_{it} \sim N\left(0, \sigma_{\varepsilon}^{2}\right)$$

where $logE\ (Y_{ij})$ represents whether individuals change over time and how fast they change. B_{0i} represents time-invariant variables (i.e., age, menopausal status, race, education, alcohol consumption, and sleep quality) measured at baseline, the parameter estimations represent differences in AL levels among these women over the study period. B_{wi} presents time variable. B_{vi} presents time-varying variables (i.e., income, smoking, and physical activity), and the parameter estimations represent the effect of changes in AL over time. AL count ratios and 95 % confidence intervals were computed. The likelihood ratio test was used to select the best-fit model (Supplemental Table 6). Model assumption also was checked whether over-dispersion (Supplemental Table 7) [22]. Moreover, we explored the interaction terms of lifestyle factors with post-baseline time to determine the differences in rates of change in AL. The same analysis procedure was applied in the Healthy-Score. All analyses were conducted using R, version 4.3.0.

Table 1
Selected characteristics of study population at baseline.

Variables	N (%)
Age	
Mean (SD.)	46.13 (2.67)
Race	
White	1008 (51.01 %)
Black	527 (26.67 %)
Asian	439 (22.22 %)
Hispanic	2 (0.10 %)
Education (baseline)	
High school or less than high school	344 (7.41 %)
Some college	632 (31.98 %)
College graduate	453 (22.93 %)
Post graduate	539 (27.28 %)
Missing	8 (0.40 %)
Leisure physical activity	
Yes	1197 (60.58 %)
No	761 (38.51 %)
Missing	18 (0.91 %)
Menopausal status	
Premenopausal	1081 (54.71 %)
Early perimenopausal	875 (44.28 %)
Missing	20 (1.01 %)
Income	
<$20,000	174 (8.81 %)
$20,000–49,999	643 (32.54 %)
$50,000–99,999	769 (38.92 %)
>$100,000	338 (17.10 %)
Missing	52 (2.63 %)
Smoked	
Yes	780 (39.47 %)
No	1182 (59.82 %)
Missing	14 (0.71 %)
Drank alcohol	
Yes	963 (48.73 %)
No	928 (46.96 %)
Missing	85 (4.31 %)
Self-rated sleep quality	
Restless	366 (18.52 %)
Average	802 (40.59 %)
Sound and restful	801 (40.53 %)
Missing	7 (0.36 %)

3. Results

Table 1 presents the descriptive statistics of the study population's characteristics at baseline. At baseline, the mean participant's age was 46 years old. Approximately half of the women were White, and over 70 % of women were college graduates or above. Over half of the women had a household income of $50,000 or more. Almost half of the women were premenopausal. Approximately 60 % of women reported having a history of leisure physical activity, 40 % ever smoked cigarettes, 50 % ever drank alcohol, and 20 % reported having restless sleep.

Table 2 displays participants' baseline AL scores generated through 12 individual risk factors, including heart rate, Systolic and Diastolic blood pressures, high and low-density lipids, total cholesterol, triglycerides, waist-to-hip ratio, serum glucose, C-reactive level, body mass index, and history of medication to metabolic cardiovascular diseases (Supplemental Table 1). Approximately 17 % of women had an AL score equal to zero, and 10 % had an AL score greater than 6. The distribution of AL score showed a decreasing trend from scores 1 (21 %) to 11 (0 %), with a mean AL score of 2.44. Fig. 1 displays the mean AL score across all seven waves and shows AL scores increased over time ($p < 0.01$).

Next, we investigated how demographic, socioeconomic, and healthy behavioral factors might affect AL changes. Fig. 2 represents the AL growth trend for each selected characteristic. We applied the mixed-effects Poisson regression model to analyze how factors might influence AL growth over seven waves. We tested the interactions between healthy behaviors and time to assess the difference in growth trends over time across the groups. Table 3 presents the results of the mixed-effects Poisson regression model. On average, a woman's AL score was expected to increase by 3 % per year (OR = 1.03, 95 % CI:1.02, 1.04) over time. Fig. 2A showed that the growth curves from all racial groups had intensified trends. However, the growth curve over time didn't differ among the three racial groups (P = 0.63). Compared to White women, Black women had 36 % increased AL (OR = 1.36, 95 % CI: 1.25, 1.48) overtime, and Asian women had 31 % decreased AL (OR = 0.69, 95 %CI = 0.63,0.76). Fig. 2B indicated a growth of AL over time for each income class, but the difference appeared insignificant (P = 0.18). Income levels also had no impact on the growth rate of AL over time (Table 3). AL at different education levels increased (Fig. 2C), but no difference among groups was observed (P = 0.36). Higher education was associated with lower AL, but only at the college level or above. The AL for female college students and graduate students was reduced by 16 % (OR = 0.84, 95%CI = 0.75, 0.94) and 14 % (OR = 0.86, 95 % CI = 0.77, 0.95) over time, respectively, compared with AL in the women with high school or less education.

Alcohol consumption appears to be a beneficial factor in reducing AL in women (Fig. 2D). Compared to never drinkers at baseline, ever drinkers at baseline had reduced AL by 22 % (OR = 0.78, 95 % CI = 0.71, 0.84) over time. Interestingly, the AL increase differed between non-drinkers and ever-drinkers (P < 0.01), and the divergence between the two trends was narrowed significantly over time. Fig. 2E and F showed that AL increased over time in all leisure physical activity and smoking groups. However, the increase didn't differ between the groups (P = 0.79 and 0.21, respectively). The mixed model result indicated that having leisure physical activity over time lowered the AL by 7 %, compared with having no physical activity over time (OR = 0.93, 95 % CI = 0.88, 0.98). At the same time, cigarette smoking overtime was associated with a 7 % (OR = 1.07, 95%CI = 1.01, 1.13) increase in AL score over time compared with nonsmoking overtime. AL in all sleep categories increased over time (Fig. 2G), but no statistically significant difference was observed across the groups (P = 0.58). Compared with women who reported restless sleep at baseline, those with "average" and "Sound and restful" sleep at baseline had significantly reduced AL by 12 % (OR = 0.88, 95%CI = 0.79, 0.98) and 16 %(OR = 0.84, 95%CI = 0.75, 0.94), respectively.

Table 4 presents the relationship between Healthy Score at baseline and AL changes over time. First, the Healthy Score was treated as a continuous variable. The AL increased by 16 % for each additional unhealthy behavior joint (OR = 1.16, 95%CI = 1.12, 1.20), indicating the accumulation of unhealthy behaviors would significantly accelerate AL increase over time. Then, the Healthy Score was treated as a categorical variable. Compared to women without unhealthy behavior, those with 1, 2, 3, and 4 had statistically significantly 1.25, 1.47, 1.53, and 1.80-folds increased levels of AL over time. The p-value for the trend was statistically significant (P < 0.01). Interestingly, a significant interaction was observed between healthy score (as a categorical variable) and time (Fig. 2H, P < 0.01), indicating the effect of unhealthy behaviors on AL growth differed by time.

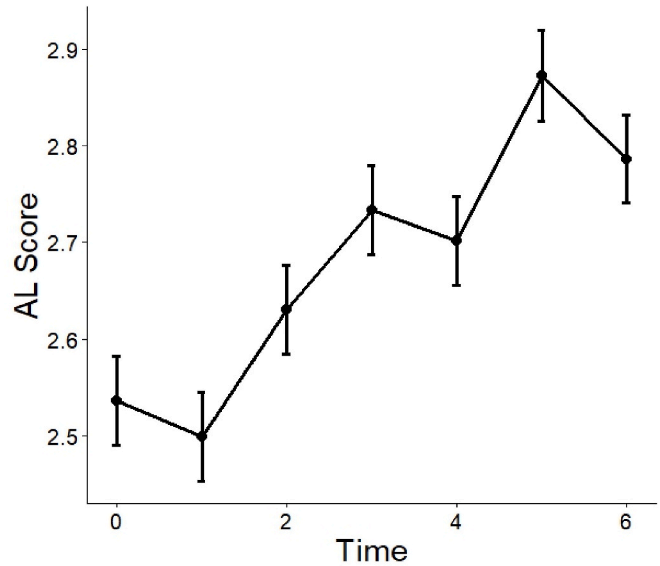

Fig. 1. Mean AL scores by waves.

Table 2
Distribution of AL scores at baseline.

AL Score	Number	Percentage (%)
0	319	16.14
1	427	21.61
2	362	18.32
3	299	15.13
4	215	10.88
5	155	7.84
6	104	5.26
7	62	3.14
8	28	1.42
9	4	0.20
10	1	0.05

4. Discussion

Prior research has shown that lifestyle factors can modify levels of AL. However, whether they can affect the AL growth trend is still being determined. Taking advantage of multi-wave longitudinal data from the SWAN study, this study examined the associations between the patterns of AL growth over time and lifestyle factors. First, we found that the AL score increased by 3 % yearly. Compared to their counterparts, women who were older and Black had higher AL, and women who were Asian and college graduates and above had lower AL overtime. Moreover, we found that women who smoked cigarettes had a higher AL than those who never smoked. On the other hand, women who self-reported ever drunk alcohol, having leisurely physical activity, or average sleep quality/sound and restful sleep at baseline had lower AL over time than their counterparts. Finally, we also identified a statistically significant

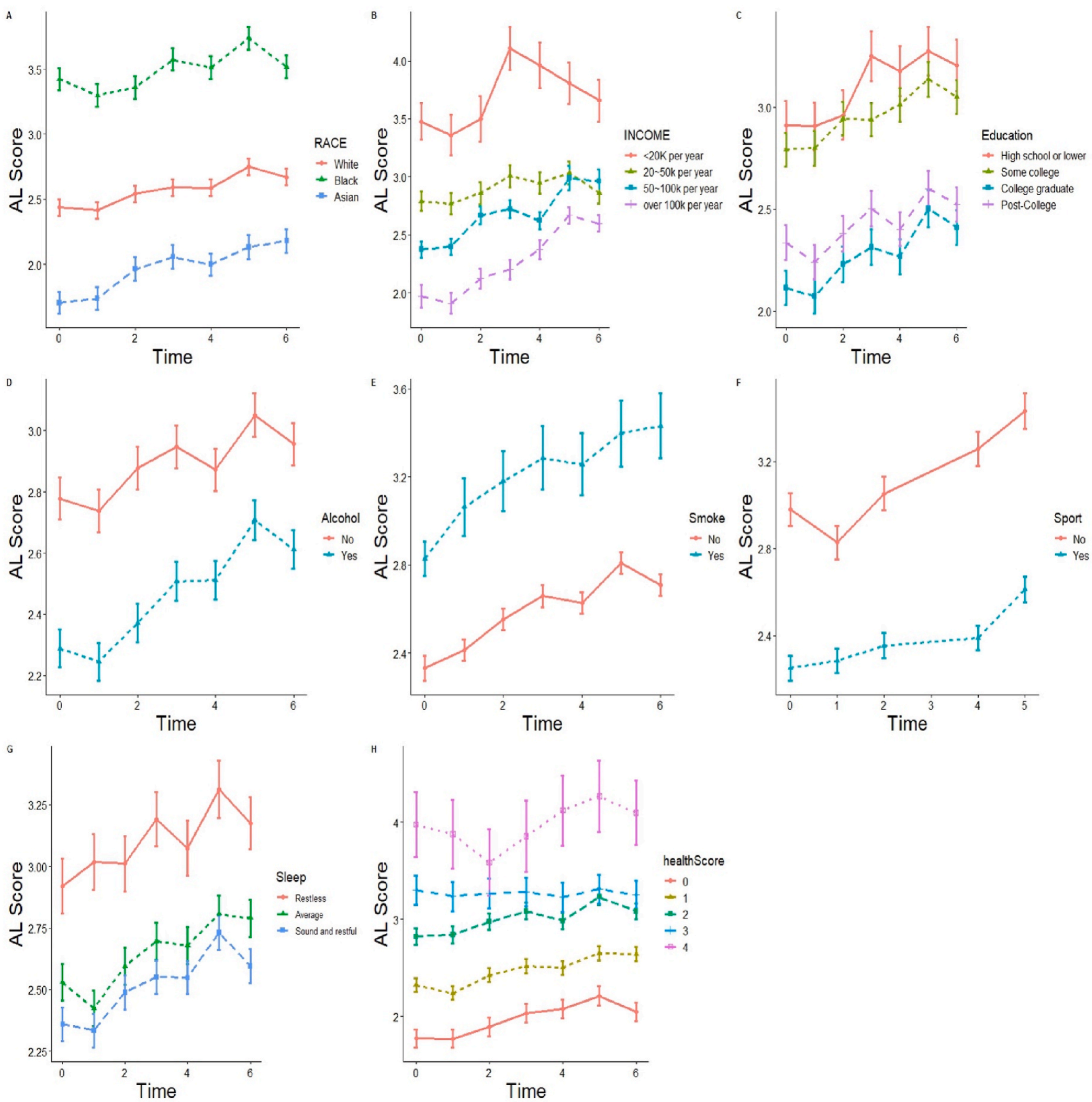

Fig. 2. AL growth trends stratified by selected factors.
1. Carbone JT, Clift J, Alexander N. Measuring allostatic load: Approaches and limitations to algorithm creation. J Psychosom Res. 2022; 163:111050. Epub 20221003. https://doi.org/10.1016/j.jpsychores.2022.111050. PubMed PMID: 36228435.

interaction between alcohol drinking and time. Furthermore, a significant trend of increasing AL score was observed with the number of lifestyle factors (ORs = 1.16, 95%CI: 1.12, 1.20 per unit increase).

Poisson mixed-effects model results indicated women's AL scores increased by 3 % per year over time, consistent with other study's findings [23]. An analysis of the Health and Retirement Study revealed that allostatic load longitudinal increases with age in the U.S [24]. Another study showed that there is an association between daily stressors and the allostatic load differed by age [25]. Specifically, exposure to high stressors led to elevated levels of allostatic load, which could only be observed in older adults. This may be because the brain gradually loses its ability to regulate stress hormones over time. In other words, physiological aging decreases the body's elastic response to stress [26–28]. Moreover, as women age, they tend to be more likely to experience the wear and tear of everyday life and many psychological challenges such as loneliness, grief, caring for family members, deterioration of one's health, etc. [29] All of these can lead to increased stress levels, and subsequently AL levels.

This study found that Black women had statistically significantly higher AL scores than white. This finding was also observed in other cross-section and longitudinal studies [20,30–33], and is consistent with Blacks showing a higher prevalence of more significant stress than whites [34]. One explanation is that systemic racism exists across the life course of Blacks [35–37]. Blacks often face adverse socio-environmental challenges and discrimination, and women fare worse. These experiences may chronically trigger stress response factors, leading to physiological disorders. A longitudinal study found high levels of discrimination and hostility significantly associated with higher AL [38]. A higher level of income is usually associated with better health. The cross-section study observed women with lower income were more likely to have higher AL levels [12,39]. Similar observations were also found in the longitudinal studies that lower income was associated with higher stress levels [40,41]. However, this association was not found in our study. This may be partly attributable to the sample compositions. Only 8.81 % of the women reported that their income was less than $20, 000 per year in the baseline, and even this percentage has decreased

Table 3
Associations between AL growth trends and selected characteristics.

	Counts Ratios [95 % CI]	P-Value
Times	1.03 [1.01, 1.05]	0.01
Age(baseline)	1.03 [1.02, 1.04]	<0.01
Race(baseline)		
White	Ref	
Black	1.36 [1.25, 1.48]	<0.01
Asian	0.69 [0.63,0.76]	<0.01
Education(baseline)		
High school or less than high school	Ref	
Some college	1.02 [0.93,1.13]	0.64
College graduate	0.84 [0.75, 0.94]	<0.01
Post graduate	0.86 [0.77, 0.95]	<0.01
Menopausal status(baseline)		
Early perimenopausal	Ref	
Premenopausal	0.95 [0.89, 1.02]	0.17
Income		
<$20,000	Ref	
$20,000–49,999	0.97 [0.90, 1.05]	0.43
$50,000–99,999	0.98 [0.90, 1.06]	0.59
>$100,000	0.97 [0.89, 1.05]	0.44
Smoked		
No	Ref	
Yes	1.07 [1.01, 1.13]	0.02
Drank alcohol(baseline)		
No	Ref	
Yes	0.78 [0.71, 0.84]	<0.01
Leisure physical activity		
No	Ref	
Yes	0.93 [0.88, 0.98]	0.01
Self-rated sleep quality(baseline)		
Restless	Ref	
Average	0.88 [0.79, 0.98]	0.02
Sound and restful	0.84 [0.75, 0.94]	<0.01
Time* Smoked		
No	Ref	
Yes	0.99 [0.97, 1.01]	0.52
Time* Leisure physical activity		
No	Ref	
Yes	1.01 [0.99, 1.02]	0.27
Time* Self-rated sleep		
Restless	Ref	
Average	1.004 [0.99, 1.02]	0.62
Sound and restful	1.01 [0.99, 1.03]	0.43
Time*Drank alcohol		
No	Ref	
Yes	1.02 [1.01, 1.04]	<0.01

Table 4
Association between AL growth trends and Healthy Score.

	OR Ratios [95 % CI]	p-Value
Score (continuous)	1.16 [1.12, 1.20]	<0.01
Score (categorical)		
0	Ref	
1	1.25 [1.13,1.38]	<0.01
2	1.47 [1.32,1.63]	<0.01
3	1.53 [1.34,1.74]	<0.01
4	1.80 [1.43,2.28]	<0.01
Score (categorical)		
Low	Ref	
High	1.28 [1.19, 1.37]	<0.01

over time. As a result, the power of the longitudinal model was not enough. More research is needed to explore the longitudinal association between income and AL in the future. On the other hand, higher education is significantly associated with a lower AL, consistent with another co-twin control study that found that years of schooling had a negative relation to AL [42]. This observation was even more pronounced among black women [43]. Moreover, another longitudinal study revealed that having a college degree can protect people from high-stress levels. Those with a college degree were 48.7 % less likely to have high perceived stress scores in later adulthood [44]. Interestingly, no interaction was observed between time with race, income, or education, indicating their influences on AL are consistent over time.

In this study, we found that women who ever smoked, had poor sleep quality, and were physically inactive had higher AL over time than their counterparts. Those findings are consistent with our previous findings and several other studies that unhealthy behaviors, including smoking, sleep disorder, and lack of exercise, could significantly aggravate the increase of AL [45–57]. Cigarette smoking is associated with the sympathetic-adrenergic blunted response, intensifying the risk of chronic stress [45,46]. Nicotine contributes to the release of dopamine in the mesolimbic system [47]' which means that people also experience anxiety due to the pause in dopamine release. The ongoing transition from smoking to non-smoking to smoking can exacerbate chronic stress. This is supported by a global perspective study that increased perceived stress levels among daily smokers were significantly associated with heavy tobacco in most countries [48]. But transitioning from smoking to nonsmoking also would longitudinally lower perceived stress by 31 % [49]. Moreover, we also found that women with higher levels of leisure physical activity were associated with a lower level of AL than their counterparts. Physical activity has long benefitted health, and regular exercise reduces stress [50,51]. Studies have shown that regular exercise could improve stress coping ability [52,53]. A recent short 3-arm randomized controlled trial revealed exercise intervention resulted in a statistically significant reduction in the allostatic load, both in the general population and among women with a family history of breast cancer, compared with the control group [54]. Sleep has an important homeostatic function, and sleep disturbances affect the brain and many body systems, which may impair brain function and lead to anxiety, depression, or a hectic lifestyle, exacerbating sleep disturbances and creating a vicious circle [55,56]. Our observation from this study is consistent with another cross-section study that high AL was significantly associated with sleep apnea, snoring, snoring/apnea, prolonged sleep latency, short sleep duration, and diagnosed sleep disturbances [57]. However, a recent systematic review and meta-analysis found no association between sleep disturbance and AL [58]. Clearly, more research is needed.

Our study found that most moderately drunk women were more likely to be in the lower AL category, consistent with other studies that moderate alcohol consumption could be a beneficial factor for health and lower AL [13,15,59,60]. Low-to-moderate alcohol consumption is associated with a reduced risk of metabolic syndrome and a lower risk of unintended depressive symptoms [61]. Other studies also indicated that under particular conditions, alcohol could help relieve stress or boost positive energy, strengthening emotional experience to reduce stress [62,63]. Also, low to moderate amounts of alcohol drinking may have positive or neutral effects on the metabolism and blood pressure, while those measurements are essential for AL. Thus, alcohol consumption appears to lower AL in this study. However, long-term drinking still could promote stress [64,65]. Another longitudinal study reported long-term drinking alcohol use contributed to increased AL [66]. This is supported by the area between non-drinkers and ever-drinkers' AL growth curve was narrowed significantly over time. Furthermore, smoking, alcohol, poor sleep quality, and being physically inactive had a joint effect on the AL score in women, suggesting more unhealthy behaviors lead to more severe stress.

Different methods have been applied to construct AL. In this study, we employed the sum of at-risk clinical scores, calculating AL based on set clinical definitions of "healthy" and "unhealthy" lab or clinical values. Compared to others, our approach has several advantages. First, it aligns with established clinical practices, ensuring the risk thresholds are evidence-based and widely recognized by healthcare professionals. Second, it uses standardized thresholds to ensure consistency in defining and comparing AL scores across studies and populations, while also enhancing the generalizability and comparability of results. Last, by reflecting real-world health risks, it improves the utility and impact of research findings, bridging the gap between scientific discovery and clinical application. Thus, it provides a robust and clinically meaningful approach to studying AL, ensuring the findings are both relevant and impactful in real-world settings.

There were limitations in this study. First, although it is generally accepted that any AL score must represent the immune, cardiovascular, and metabolic systems biomarkers, the measurements for creating the AL were limited by the availability of SWAN, and there is no consensus on how to construct the AL score [67–69]. Therefore, we cannot rule out that choosing a different way to build the AL score may produce different results. Second, due to the sample age ranging from 42 to 52 and the limited information on Hispanic women, the findings cannot be generalized to women of all ages and Hispanic women. More research is needed to confirm the association between unhealthy behaviors and AL scores in Hispanics and other women of age. Finally, this study only comprised a short follow-up (from 1996 to 2003), which may have underestimated the impact of unhealthy behaviors on the AL. A longer and more extensive Biomed prospective study research is needed to confirm the fings of this study.

Nevertheless, this is the first study to assess the role of healthy behaviors on AL growth over time. In summary, we found that all four healthy behaviors, including cigarette smoking, alcohol drinking, leisure physical activity, and sleep, could modify AL growth over time. Our results support healthy behavior promotion or interventions to reduce chronic stress and ultimately improve overall health among middle-aged women.

Informed consent

Written informed consent was obtained from all participants.

Ethics approval

All procedures performed in this study were approved by the Institutional Review Board at Virginia Commonwealth University and in accordance with the ethical standards of 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Data sharing

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhip.2025.100590.

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