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The psychosocial anti-inflammatories: Sense of control, purpose in life, and social support in relation to inflammation, functional health and chronic conditions in adulthood

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ABSTRACT

Objective: Three psychosocial variables were examined as predictors of chronic inflammation, functional health, and number of chronic conditions.

Methods: This cohort study used the Midlife in the United States biomarker sample. Data were collected in 2004–2009 (M2) and 2013–17 (M3). The sample included 1244 adults ages 34 to 82 (M = 54.50, SD = 11.7), with 57 % women, 79 % white, and education from 6 to 20 years (M = 14.47, SD = 2.65). Sense of control, purpose in life, and social support were included as indicators of a psychosocial latent factor. Inflammation was measured with Interleukin-6, C-reactive Protein, E-Selectin, Fibrinogen, and Intracellular Adhesion Molecule-1. Covariates included age, sex, education, race, and household income. Functional health and chronic conditions were assessed M = 9.27 (SD = 0.78) years after the psychosocial variables and M = 7.06, (SD = 1.47) years after inflammation.

Results: Using a structural equation model and controlling for covariates, higher levels on the psychosocial variables predicted lower inflammation ($\beta = -0.12$, 95 % CI -0.22 to −0.02; $p = .016$), better functional health ($\beta = 0.25$, 95 % CI 0.18 to 0.32; $p < .001$), and fewer chronic conditions ($\beta = -0.22$, 95 % CI −0.30 to −0.15; $p < .001$), with inflammation a mediator (indirect effects: functional health, $\beta = 0.03$, 95 % CI 0.00 to 0.05, $p = .020$ and chronic conditions, $\beta = -0.02$, 95 % CI -0.03 to −0.00, $p = .036$).

Conclusions: Adaptive psychosocial beliefs and supportive relationships are important as they can provide motivation for engaging in health-promoting behaviors and can reduce stress that can lead to chronic inflammation and poor health. The results can inform a psychosocial prescription for health.

1. Introduction

There is much interest in identifying modifiable lifestyle factors that promote healthy aging. Typically, the focus is on reducing health damaging behaviors such as smoking or alcohol use and increasing health-promoting ones such as keeping a healthy weight and exercising regularly [1]. What is often missing from these recommendations are the psychosocial factors that also show significant relationships with health and longevity [2–4]. Moreover, following the recommended regimen for health promoting behaviors is to a large extent dependent on having adaptive psychosocial attitudes and beliefs and supportive relationships. The three psychosocial dimensions of interest in this study are consistently found to be related to health, although they are typically examined in separate studies. These include a high sense of control [3,5], purpose and meaning in one's life [2,6–8], and supportive social connections [4]. These psychosocial factors are important because they can facilitate stress reduction [9]. They also can motivate healthy behaviors that promote good health and well-being [3]. Those who have a strong sense of control, purpose in life, and social support are more likely to engage in adaptive health behaviors such as physical exercise [10] and avoid health-damaging ones such as smoking [11]. It is noteworthy that the natural trajectory for these adaptive psychosocial factors is a downward trend with aging [3,5,12,13]. Thus, it becomes particularly important to find ways to nurture and maintain them throughout life and to understand how they are related to health.

Although these psychosocial factors are typically examined individually in separate studies they do not exist in isolation. There is some evidence from past research that sense of control and social support are

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moderately positively correlated and purpose in life is a significant predictor of control over health [14]. We were interested to examine these three important psychosocial variables together in one study. This allowed us to examine their intercorrelations and to consider their collective or combined effect in comparison to separate or net effects, which to our knowledge has not been investigated before.

We also were interested in whether these psychosocial factors can be linked to health through a physiological biomarker pathway. Thus, we considered chronic inflammation as a potential mechanism that could link the psychosocial factors with the health outcomes [15]. Inflammation, the body's process of fighting against harm (e.g. infections, injuries, and toxins) plays an important role for health. When cells are damaged, the body releases chemicals that trigger a response from the immune system. Acute inflammation is beneficial as it facilitates healing. Chronic inflammation, when the response lingers, can have a negative impact on tissues and organs. This plays a role in a range of conditions including cancer, asthma, and aging related diseases. The term *inflammaging* [16] indicates how chronic inflammation can affect chronic diseases and aging-related functional changes in multiple systems including neurodegenerative diseases such as Alzheimer's and Parkinson's Disease, metabolic disorders such as type 2 diabetes and cancer, musculoskeletal disorders such as osteoarthritis, osteoporosis, and sarcopenia, and cardiovascular diseases such as atherosclerosis and stroke.

Lifestyle factors such as diet play an important role in inflammatory processes, as there are foods that promote inflammation, such as fried food and processed meats. In contrast, there are anti-inflammatory foods including those with omega-3 fatty acids (e.g., salmon) and fruits (e.g., blueberries). There are also the familiar pharmaceutical non-steroidal anti-inflammatories such as aspirin, ibuprofen, naproxen, and Celecoxib that are used for arthritis and other sources of pain associated with inflammation. The potential role of psychosocial factors in inflammatory processes has only received limited attention [17].

There is some evidence that psychosocial variables are related to level of inflammation. Pro-inflammatory responses marked by increases in inflammation can be caused by stress, discrimination, anger, trauma, neuroticism, depression, anxiety, bereavement, negative attitudes, pessimism, and social strain/conflict [17,18]. In contrast, there are psychosocial factors that have been found to reduce or prevent inflammation and can be considered anti-inflammatories. Those with higher purpose in life have lower inflammation [2,19,20]. A number of studies have found that greater social strain is associated with higher inflammation levels [21–23]. Social support and social integration were significantly related to lower levels of inflammation in a meta-analysis [24]. Positive social relationships were related to lower IL-6, for women [25], especially for those who were able to give the most support in the relationships [26]. Although there have been fewer studies examining sense of control in relation to inflammation, we were interested to examine this psychosocial variable given its strong association with health, health behaviors, and longevity and its downward trajectory in later life [3]. Individuals with a strong sense of control are also higher on other psychosocial factors [5], have less stress reactivity [27] and they are more likely to engage in health-promoting behaviors than those with lower control beliefs. For example, those with higher sense of control have higher levels of social support [5] and engage in more physical activity [28,29]. Although one recent study found that those with a higher sense of control had lower levels of inflammation [30] another recent study did not show a significant relationship between control beliefs and inflammation [31].

We examined the role of a latent factor comprised of three psychosocial factors, sense of control, purpose in life, and social support in relation to inflammation, functional health and number of chronic conditions. We predicted that those who had higher levels of these psychosocial factors would show better functional health and fewer chronic conditions after 9 years and that inflammation would mediate these relationships. In supplementary analyses, we also examined the relationship of the three psychosocial variables individually and all together to compare their separate effects as well as their net effects.

2. Methods

All university review boards involved in the study (University of Wisconsin-Madison, Georgetown University, UCLA and Brandeis University) approved this cohort study. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

2.1. Sample

The participants are from the Midlife in the United States (MIDUS) and Milwaukee biomarker sub-study [32]. This included 1244 adults ranging in age from 34 to 82, M = 54.50, SD = 11.7) with 57 % women, 79 % white, and a range of education from 6 to 20 years (M = 14.47, SD = 2.65).

For additional details about the Biomarker study and comparisons with the main MIDUS survey sample see Love et al., 2010 [32]. Although there were some small differences, in that the Biomarker sample had a higher level of education and was less likely to smoke and more likely to use alternative medicine therapies, they were otherwise comparable to the main MIDUS participants in terms of most other demographic and health variables.

Our study sample included those who had data for at least one of the inflammatory markers measured at the second wave of MIDUS. We adopted a full information maximum likelihood (FIML) method to estimate the parameters using all available data [33]. The sample size differs across variables given there is some missing data. We compared the participants from the Biomarker study who had health data (functional health and chronic conditions) at MIDUS 3 with those who were missing the health data ($N = 194$). Participants with the health variables at M3 were younger ($p < .001$) and reported higher income ($p < .001$), sense of control ($p < .001$), purpose in life ($p < .001$) and social support ($p = .026$), as well as lower inflammation ($p < .001$), better functional health (<0.001) and fewer chronic conditions (<0.001).

2.2. Measures

Covariates and psychosocial measures were assessed by self-administered questionnaires at the second wave of the MIDUS study (M2), collected from 2004 to 2005. Inflammation was assessed on average 2 years later (M = 2.18, SD = 1.27), between 2004 and 2009. Health measures were assessed by self-report at the third wave (M3), between 2013 and 2017, on average 9 years (M = 9.27, SD = 0.78) after the M2 psychosocial variables and M = 7.06, (SD = 1.47) years after inflammation.

2.2.1. Functional health

Functional health was assessed at M3 and was computed with seven items from the Physical Functioning subscale from the SF-36 Health Survey [34]. The seven items assessed the extent to which the participants' health limits them in different activities. Activities included carrying groceries, bathing/dressing, climbing several flights of stairs, ending/kneeling/stooping, walking more than one mile, walking several blocks, and walking one block. The scores ranged from 1(A lot) to 4 (Not at all) and were transformed so that the lowest possible score was 0 and the highest possible score was 100 with higher scores indicating fewer limitations or better functional health ($\alpha = 0.92$, $\omega = 0.93$).

2.2.2. Chronic conditions

Chronic conditions were assessed at M3 by asking if in the past twelve months, you have experienced or been treated for any of a list of 30 conditions such as diabetes, high blood pressure, stroke, ulcer, cancer. Those indicated as yes were coded as 1 and the total number was

computed with a possible range of 0 to 30.

2.2.3. Psychosocial factors

We examined three psychosocial factors: sense of control, purpose in life, and social support, which were assessed at M2.

2.2.4. Sense of control

This was assessed with a 12-items covering perceptions of control over life outcomes [35]. The score was calculated by averaging two subscales from which measured personal mastery ("I can do just about anything I set my mind to") and perceived constraints ("Many things interfere with what I want to do"). The scores were assessed on a seven-point Likert scale with 1 representing strongly agree and 7 representing strongly disagree. Scores were reverse coded for personal mastery such that a high score indicates a higher sense of control. The sense of control scale demonstrated good internal consistency ($\alpha = 0.82$, $\omega = 0.86$).

2.2.5. Purpose in life

This was evaluated by seven questions from the Ryff Scales of Psychological Well-Being [36]. Participants answered the items such as, "I sometimes feel as if I've done all there is to do in life" on a 1 (Strongly agree) to 7 (Strongly disagree) Likert scale. Positively worded items were reverse coded and the mean score was computed so that higher scores reflect greater purpose in life. The purpose in life subscale demonstrated acceptable internal consistency ($\alpha = 0.69$, $\omega = 0.70$).

2.2.6. Social support

To assess the quality of social support, we included 4 items covering support (e.g., understand the way you feel) and 4 items covering strain (e.g., criticize you) for each of the following relationships: family, friends and spouse/partner. The scores ranged from 1 (Never) to 4 (Often) and the strain items were recoded and averaged so that higher values indicate higher quality of social support [37]. The social support scale demonstrated a good internal consistency within our analysis sample ($\alpha = 0.87$, $\omega = 0.85$).

2.2.7. Chronic inflammation

Chronic inflammation was assessed using a composite measure of inflammation (see Hostinar et al. 2015 [38]. The measure of inflammation was derived from fasting blood samples that included serum markers of interleukin-6, C-reactive protein, E-Selectin, fibrinogen, and intracellular adhesion molecule-1 (I-CAM-1). CRP and fibrinogen (*N* Antiserum to Human Fibrinogen; Dade Behring Inc., Deerfield, IL) were quantified using a particle enhanced immunonephelometric assay (BNII nephelometer, Dade Behring Inc., Deerfield, IL). IL-6 (Quantikine High-sensitivity enzyme-linked immunosorbent assay ELISA kit #HS600B; R & D Systems, Minneapolis, MN), E-Selectin (Parameter Human E-Selectin Immunoassay; R & D Systems, Minneapolis, MN), and I-CAM (Parameter Human ICAM-1 Immunoassay; R & D Systems, Minneapolis, MN) were measured using ELISA assays. Each measure was standardized to a z-score and then averaged to create the composite score. The internal consistency reliability is $\alpha = 0.56$, $\omega = 0.57$.

2.2.8. Covariates

We included age, sex (0 = men, 1 = women), number of years of education (Range = 6–20), race (0 = White, 1 = Nonwhite), and total household income as covariates given their association with the psychosocial and health variables. Total household income, which ranged from $0 to $300,000 was winsorized and then standardized to a z-score.

2.3. Statistical analysis

We conducted a Structural Equation Model (SEM) using the 'lavaan' package [39] in R which included a measurement model and a structural model. We included one latent factor for the psychosocial variables and the remaining variables were observed. The psychosocial latent factor included sense of control, purpose in life, and social support as indicators. The structural model tested whether the relationship between the psychosocial factor at MIDUS 2 and health at M3 was mediated by inflammation at M2, with the covariates included. We used a full information maximum likelihood (FIML) estimator so that all observations could be used in the model.

3. Results

Descriptive statistics and correlations are presented in Table 1. Of interest is that the intercorrelations of the psychosocial variables ranged from 0.38 to 0.59, with the highest correlation between sense of control and purpose in life. All three psychosocial variables are significantly correlated with inflammation, functional health, and chronic conditions. The SEM model had an acceptable fit, $\chi2(26) = 209.95$, $p < .001$, CFI = 0.90, RMSEA = 0.08. Results are presented in Table 2 and Fig. 1 and show that all three of our indicators, sense of control, purpose in life, and social support, contributed to the latent psychosocial factor, with loadings of 0.75, 0.78, 0.54, respectively. The results also showed that the psychosocial factor was directly related to inflammation ($\beta = -0.12$, 95 % CI -0.22 to −0.02; $p = .016$) assessed on average 2 years later, as well as functional health ($\beta = 0.25$, 95 % CI 0.18 to 0.32; $p < .001$) and chronic conditions ($\beta = -0.22$, 95 % CI -0.30 to −0.15; $p < .001$) on average 9 years later, controlling for the covariates. In addition, the indirect effects were significant for both functional health ($\beta = 0.03$, 95 % CI 0.00 to 0.05, $p = .020$) and number of chronic conditions ($\beta = -0.02$, 95 % CI -0.03 to −0.00, $p = .036$), with inflammation as a significant mediator. Fig. 1 shows the relationship of the psychosocial factor to inflammation, functional health and chronic conditions as well as the indirect effects through inflammation.

Given that the data set contains a small number of twins and siblings, we did a sensitivity analysis by adding a cluster parameter to the SEM model to incorporate cluster robust standard errors. The results remained the same.

Additional sensitivity analyses (see Supplementary Tables 1 and 2) were conducted with SEM to examine each of the three psychosocial factors in separate models (Models 1–3), and simultaneously to examine net effects (Model 4). All models adjusted for the covariates and tested for mediation. When entered into the models separately, results indicated that each of the three models had a reasonable fit (Sense of Control Model 1: $\chi2(5) = 92.23$, $p < .001$, CFI = 0.93, RMSEA = 0.13; Purpose in Life Model 2: $\chi2(5) = 95.06$, $p < .001$, CFI = 0.93, RMSEA = 0.13; Social Support Model 3: $\chi2(5) = 77.20$, $p < .001$, CFI = 0.94, RMSEA = 0.12) although all RMSEAs were > 0.08. Each of the psychosocial variables when examined separately predicted inflammation, functional health, and chronic conditions and mediation was found for all three, although for purpose in life the significance level was $p = .06$ (see Supplementary Table 1).

When the psychosocial variables were entered together into one model, the model fit was also reasonable (Model 4: $\chi2(5) = 76.63$, $p < .001$, CFI = 0.96, RMSEA = 0.12), however the RMSEA was >0.08, and a number of the previously significant relationships were no longer significant. The results showed that only social support was directly related to inflammation ($\beta = -0.10$, 95 % CI -0.17 to −0.02, $p = .018$), but not sense of control ($\beta = -0.04$, 95 % CI -0.13 to 0.05, $p = .40$) or purpose in life ($\beta = -0.02$, 95 % CI -0.11 to 0.08, $p = .77$). Sense of control, although not purpose in life or social support, was directly related to functional health (sense of control: $\beta = 0.20$, 95 % CI 0.12 to 0.27, $p < .001$; purpose in life: $\beta = 0.03$, 95 % CI −0.04 to 0.11, $p = .41$; social support: $\beta = 0.03$, 95 % CI -0.04 to 0.10, $p = .43$) and chronic conditions (sense of control: $\beta = -0.16$, 95 % CI -0.23 to −0.08, $p < .001$; purpose in life: $\beta = -0.03$, 95 % CI -0.11 to 0.04, $p = .39$; social support: $\beta = -0.05$, 95 % CI -0.11 to 0.02, $p = .19$). The indirect effects, with inflammation as a mediator, were only significant for social support to functional health ($\beta = 0.02$, 95 % CI 0.00 to 0.04, $p = .025$) and chronic conditions ($\beta = -0.01$, 95 % CI −0.03 to 0.00, $p = .047$), see

Table 1
Means, standard deviations, and correlations for all variables[a].

	M(SD)	Min/Max	1	2	3	4	5	6	7	8	9	10
1. M2 Age	54.50 (11.71)	34, 84										
2. M2 Sex	57 % Women	0, 1	−0.04									
3. M2 Education	14.47 (2.65)	6, 20	−0.03	−0.09*								
4. M2 Race	0.21 (0.41)	0, 1	−0.16*	0.08*	−0.21*							
5. M2 Income[b]	70,244.75 (59,042.18)	0, 300,000	−0.16*	−0.11*	0.34*	−0.22*						
6. M2 Sense of Control	5.59 (0.99)	1, 7	0.06*	−0.05	0.17*	−0.11*	0.16*					
7. M2 Purpose in Life	5.63 (0.97)	1, 7	0.07*	0.04	0.14*	−0.08*	0.18*	0.59*				
8. M2 Social Support	3.44 (0.49)	1, 4	0.14*	0.04	0.09*	−0.16*	0.11*	0.38*	0.43*			
9. M2 Inflammation	0.00 (0.61)	−1, 4	0.07*	0.09*	−0.17*	0.20*	−0.17*	−0.10*	−0.09*	−0.09*		
10. M3 Functional health	74.98 (28.3)	0, 100	−0.19*	−0.15*	0.25*	−0.19*	0.25*	0.27*	0.19*	0.14*	−0.34*	
11. M3 Chronic Conditions	3.45 (2.92)	0, 16	0.11*	0.15*	−0.18*	0.20*	−0.22*	−0.23*	−0.17*	−0.15*	0.23*	−0.56*

FIML Sample = 1244.
[a] *M*,= mean and SD = standard deviation, respectively. M2 = MIDUS 2, M3 = MIDUS 3. Min/Max- Minimum/Maximum.
[b] Raw values presented here. Income was winsorized and standardized for the analyses * $p < .05$.

Table 2
Unstandardized path coefficients from structural equation model showing the relationships of the direct and indirect effects for the psychosocial factor, inflammation, functional health, and chronic conditions.[a]

Variables	*b (SE)*	*p*	95 % CI
M2 Psychosocial Factor			
M2 Sense of Control	1.00 (0.0)		1.00, 1.00
M2 Purpose in Life	1.00 (0.1)	<0.001	0.86, 1.15
M2 Social Support	0.35 (0.0)	<0.001	0.29, 0.42
M2 Inflammation			
M2 Psychosocial Factor	−0.09 (0.0)	0.016	−0.17, −0.02
M3 Functional Health			
M2 Age	−0.54 (0.1)	<0.001	−0.69, −0.39
M2 Sex	−5.54 (1.58)	<0.001	−8.63, −2.45
M2 Education	1.10 (0.3)	0.31	0.45, 1.75
M2 Race	−6.41 (2.1)	0.004	−10.75, −2.07
M2 Income (z)	2.32 (0.8)	0.004	0.75, 3.89
M2 Psychosocial Factor	9.20 (1.2)	<0.001	6.83, 11.57
M2 Inflammation	−11.58 (1.4)	<0.001	−14.35, −8.82
Indirect Effect:	1.07 (0.5)	0.020	0.17, 1.97
M3 Chronic Conditions			
M2 Age	0.04 (0.0)	<0.001	0.02, 0.05
M2 Sex	0.62 (0.2)	<0.001	0.29, 0.95
M2 Education	−0.04 (0.0)	0.31	−0.11, 0.03
M2 Race	0.83 (0.3)	<0.001	0.32, 1.35
M2 Income (z)	−0.26 (0.1)	0.002	−0.43, −0.09
M2 Psychosocial Factor	−0.86 (0.1)	<0.001	−1.13, −0.58
M2 Inflammation	0.67 (0.2)	<0.001	0.32, 1.02
Indirect Effect:	−0.06 (0.0)	0.036	−0.12, −0.00

ab, *SE*, and *95 % CI* are used to represent the unstandardized beta estimate, standard error and 95 % confidence interval. M2 = MIDUS 2, M3 = MIDUS 3. FIML Sample = 1244.

Supplementary Table 2.

4. Discussion

As hypothesized, those individuals who had lower levels of the psychosocial factor had worse functional health and more chronic conditions after 9 years, and higher chronic inflammation. Thus, the results suggest that a combination of having a strong sense of control, purpose in life, and social support is important for maintaining good health and that inflammation is one plausible mechanism [3]. We tested these relationships in three different ways. The first model (Table 2 and Fig. 1) considered the three psychosocial variables as a latent factor and tested the direct and indirect effects. With this combined approach to assess psychosocial variables using a latent construct, the results confirmed our hypotheses that all three psychosocial variables would be related to functional health and chronic conditions after 9 years and that these relationships were mediated by inflammation.

We also tested each psychosocial variable separately and found that all of them were related to inflammation and to 9-year changes in both health variables, and inflammation mediated the relationships. This confirms what others have found for purpose in life [2,19,20] and social support [21–23], and provides new information for sense of control. The rationale for conducting the initial analysis with a psychosocial latent factor was the expectation that entering them all simultaneously would likely obscure some of the relationships due to the moderate correlations among them, especially between sense of control and purpose in life. Indeed, that is what we found (see Supplementary Table 2) as sense of control was the only psychosocial variable to show significant relationships with the health outcomes, and social support was the only variable to show indirect effects. Yet, when entered individually (Supplementary Table 1), both sense of control and purpose in life as well as social support showed significant direct and indirect effects with health and inflammation. We note that sense of control and purpose in life are more highly correlated with each other than they are with social support, which could explain why their net effects were reduced.

Maintaining good functional health and reducing chronic conditions in later life are both critical aims for maintaining an independent lifestyle and overall well-being and quality of life. Poor physical functioning and multiple chronic conditions are related to higher rates of hospital admittance and morbidity [40] as well as greater risk of falls [41]. The present study supports previous research which suggests that there are important modifiable psychological attitudes and social factors that have protective effects against physical problems and poor health [14,42,43]. Stress reduction is one likely explanation for the links between these psychosocial variables and inflammation. All of the psychosocial variables included in this study have been linked to reducing or coping with stress [7,27,44,45], and stress is implicated in increased inflammation [21]. Another possible explanation is that the psychosocial variables have been linked to positive health behaviors such as not smoking [11] or physical activity [10,14,28], which are also associated with lower inflammation levels.

In future research, it will be interesting to consider additional pathways linking the psychosocial variables to inflammation and health. For example, Zilioli et al., 2015 [46] found that purpose in life predicted allostatic load, which includes inflammation as one of seven physiological systems. And they found that this relationship was mediated by health locus of control, in that those with higher purpose also had a greater sense of control over their health. In another study [30] inflammation mediated the link between discrimination and cardiovascular conditions for those who reported low levels of perceived

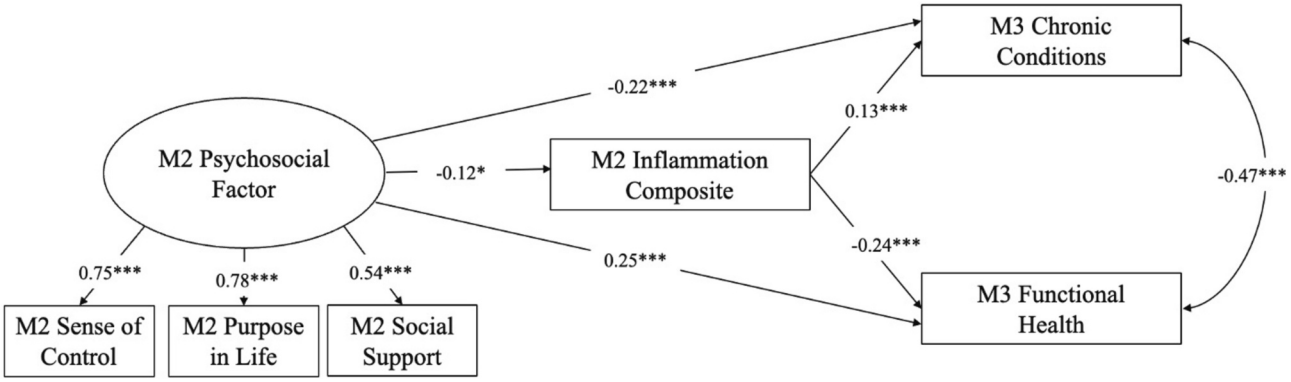

Fig. 1. The Relationships Between the Psychosocial Factor, Inflammation, Functional Health and Chronic Conditions. Over 9-years.
Covariates include M2 age, sex, education, race, and total household income (z). The indirect effect of M2 inflammation on the relationship between the M2 psychosocial factor and M3 functional health (β = 0.03, 95 % CI 0.00 to 0.01; $p = .020$) and M3 chronic conditions (β = −0.02, 95 % CI −0.03 to −0.00; $p = .036$) were significant. * $p < .05$. ** $p < .01$ *** $p < .001$. M2 = MIDUS 2, M3 = MIDUS 3.

control. A higher sense of control was protective in that those with a higher sense of control did not experience the negative health effects of discrimination.

Our results suggest that control beliefs, purpose in life, and social support may be meaningful targets for health interventions. In the present study we did not test whether one or some combination of the psychosocial variables would be the most important to target for interventions. Rather, the findings suggest that a combinatorial approach in which multiple variables are addressed is reasonable. It would be of interest to examine different combinations of the three psychosocial variables and consider interactions between the psychosocial variables to examine the optimal combination for different health behaviors and outcomes. This could be useful for informing interventions for enhancing health-related attitudes and beliefs. For those who have low levels of social support, for example, it would be informative to explore to what extent fostering a higher sense of control and a greater purpose in life can help to increase their support and mitigate health risks. For those with a low sense of control and low purpose in life, interventions to increase both could help to motivate a healthier lifestyle. All three of the psychosocial variables may be increased through providing support, teaching emotion regulation techniques or cognitive behavioral techniques such as cognitive restructuring, or helping individuals to find more meaning in life through social engagement such as volunteering [3,47].

4.1. Strengths and limitations

While this study expands on previous studies by investigating multiple psychosocial factors as protective for inflammation and health in a more diverse population, it is not without limitations. First, we utilized self-reported assessments for the study variables except for inflammation. Although health can be measured in more objective ways in future studies, it is the case that psychological variables are typically measured in a subjective fashion. We also did not control for medications that could be related to levels of inflammation as some of these are directly related to the dependent variable, chronic conditions. Thus, it is not clear whether inflammation levels were affected by taking anti-inflammatory prescription or non-prescription medications. Lastly, due to selective attrition, as is typically found in longitudinal samples [48], the limits to generalizability of results must be considered.

5. Conclusions

In sum, the results of this study suggest that psychosocial factors that are associated with inflammation as well as better functional health and fewer chronic conditions are a worthy target of intervention for the aging population. The results have implications for considering a psychosocial prescription for maintaining functional health and reducing chronic conditions in midlife and later adulthood. Identifying individuals who are low in any of these psychosocial factors and supplying techniques to enhance these constructs may produce downstream effects on functional health and chronic conditions through reduced inflammation. This could lead to greater quality of life in middle age and beyond as well as to reduced health care costs.

CRediT authorship contribution statement

Margie E. Lachman: Writing – original draft, Methodology, Funding acquisition, Conceptualization. **Kylie A. Schiloski:** Writing – review & editing, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary tables for this article can be found online at https://doi.org/10.1016/j.jpsychores.2024.111957.

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