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The longitudinal association of psychological resources with chronic conditions and the mediating roles of health behaviours and allostatic load

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ABSTRACT

Objective: To investigate the association of psychological resources with the prevalence of chronic conditions up to 10 years later, and the mediating roles of health behaviours and allostatic load. **Design:** Participants from the *Midlife in the United States* study ($N = 850$) completed surveys and biomarker assessments over the course of 10 years. **Main Outcome Measures:** Primary outcome was the prevalence of chronic conditions later in life, controlling for baseline chronic conditions. Secondary outcomes were health behaviours and allostatic load. Direct and indirect associations between psychological resources and chronic conditions were examined. **Results:** Psychological resources were negatively associated with chronic conditions directly ($b = -.177$, $p < .05$) and indirectly through health behaviours ($b = -.026$, $p < .05$), but not through allostatic load ($b = -.000$, $p > .05$). Psychological resources were positively associated with health behaviours ($b = .130$, $p < .01$), but no association was found between psychological resources and allostatic load ($b = -.002$, $p > .05$). Health behaviours were negatively associated with chronic conditions ($b = -.201$, $p < .01$), and allostatic load was positively associated with chronic conditions ($b = .197$, $p < .05$). **Conclusion:** Findings highlight the beneficial influence of psychological resources on chronic conditions, and the mediating role of health behaviours.

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allostatic load; chronic conditions; health behaviours; longitudinal; psychological resources

Introduction

The prevalence of chronic health conditions among adults in the U.S. is increasing, and is compounded by the rising prevalence of multiple chronic conditions (Ward & Schiller, 2013). As of 2012, 50% of adults had at least one chronic condition, 25% had two or more, and of those aged 65 and older, 23% had more than three (Chevarley, 2015; Ward, Schiller, & Goodman, 2014). The high prevalence of chronic conditions is a serious problem, given its negative impact on public health and the economy. Chronic

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conditions represent seven of the top 10 causes of death in the U.S., and multiple chronic conditions account for 71% of the nation's total health care expenditures (Gerteis et al., 2014; National Center for Health Statistics, 2017). Chronic conditions are also associated with a lower quality of life, higher risk of physical disabilities, and premature death (Bauer, Briss, Goodman & Bowman, 2014). Given the significant physical, psychological, and economic consequences associated with chronic conditions, it is crucial to examine modifiable factors that positively influence these health conditions.

Chronic conditions and psychological resources

Psychological resources have demonstrated beneficial associations with chronic conditions, but have not received as much attention from researchers as lifestyle-related factors (e.g. exercise and diet). Psychological resources are defined as individual differences in positive psychological functioning that influence mental and physical health outcomes (Taylor & Broffman, 2011), and include inner abilities, strengths, skills and beliefs that influence how individuals manage challenging life events (Taylor & Stanton, 2007). Evidence supports protective associations between psychological resources and health outcomes: Greater psychological resources are associated with lower risk of morbidity (Pressman & Cohen, 2005) and mortality (Chida & Steptoe, 2008), and have a positive impact on chronic conditions including cardiovascular diseases (Cohen, Bavishi, & Rozanski, 2016), depression (Scheier, Carver, & Bridges, 1994) and type 2 diabetes (Tsenkova, Love, Singer, & Ryff, 2007).

The theoretical model of psychological well-being suggests that certain psychological resources promote healthy living and thriving (Ryff, 1995). These resources include positive affect, life satisfaction, purpose in life, self-acceptance, positive relations with others and environmental mastery. In addition to those six constructs, a review of psychosocial resources in the context of chronic disease highlights optimism and self-esteem as the two leading personality and self/ego-related resources with a large amount of evidence supporting their association with physical and mental health outcomes (Schetter & Dolbier, 2011). These psychological resources are multidimensional and encompass the extent to which individuals maintain positive outcome expectancies (Masten, Cutuli, Herbers, & Gabrielle-Reed, 2009); have a positive sense of self (Taylor & Broffman, 2011); experience positive emotions (Folkman & Moskowitz, 2000); favourably evaluate their overall quality of life; have purpose and direction in life; accept personal strengths and weaknesses; have satisfying and trusting relationships with others; and have a sense of control over their environments (Ryff, 2014). The beneficial association between these individual psychological resources and health outcomes is well-documented. However, few studies have examined the combined influences of these psychological resources on health outcomes. Integrated resource theories view psychological resources broadly, and rather than focus on a single psychological resource, suggest that psychological resources tend to correlate with one another and cluster together synergistically (Hobfoll, 2002). Possessing a strong reservoir of psychological resources can therefore benefit physical and mental health.

The above psychological resources have shown particularly beneficial influences on chronic conditions. According to a meta-analysis, greater *optimism* is consistently associated with lower prevalence of numerous physical health outcomes including cardiovascular disease, cancer, diabetes, hypertension, and HIV/AIDS (Rasmussen, Scheier, & Greenhouse, 2009), and has also been associated with lower incidence of depressive symptoms (Giltay, Zitman, & Kromhout, 2006). *Self-esteem* has been found to protect against coronary heart disease (Lundgren, Garvin, Jonasson, Andersson, & Kristenson, 2015), and is associated with improved symptom severity among individuals with rheumatoid arthritis and asthma (Juth, Smyth, & Santuzzi, 2008). *Positive affect* has been negatively associated with both adverse physical symptoms and morbidity (Pressman & Cohen, 2005), and *life satisfaction* has been linked with lowered risk of cancer, stroke and type 2 diabetes (Feller, Teucher, Kaaks, Boeing, & Vigl, 2013). *Purpose in life* has been inversely associated with cardiovascular disease (Cohen et al., 2016), and low *self-acceptance* has been related to higher depression and anxiety (MacInnes, 2006). *Positive relations with others* and e*nvironmental mastery* have been associated with fewer chronic conditions and adverse health symptoms (Ryff, Radler, & Friedman, 2015). Individuals possessing larger quantities of these specific psychological resources may thus be protected against the development of chronic diseases.

Mediators linking psychological resources to chronic conditions

Emerging research suggests two potential mechanisms through which psychological resources may exert beneficial influences on chronic conditions: (1) health behaviours and (2) physiological stress regulatory systems (i.e. allostatic load). Engagement in unhealthy behaviours and greater activation of stress regulatory systems predispose individuals to chronic conditions (Christensen & Antoni, 2002; Salleh, 2008), but psychological resources positively influence health behaviours (Boehm et al., 2018; Taylor & Broffman, 2011) and help reduce the activation of stress regulatory systems (Jamieson, Mendes, & Nock, 2013; Wiley, Bei, Bower, & Stanton, 2017). Prior empirical and conceptual research supports the mediational role of health behaviours (Steptoe, Wright, Kunz-Ebrecht, & Iliffe, 2006) and allostatic load (Wiley et al., 2017) in the association between various psychological resources and health outcomes. Additionally, various health behaviours including smoking, physical activity and alcohol intake have been associated with allostatic load (Forrester, Leoutsakos, Gallo, Thorpe, & Seeman, 2019; Hampson, Goldberg, Vogt, Hillier, & Dubanoski, 2009), suggesting a potential bidirectional relationship between health behaviours and allostatic load.

Health behaviours

Health-related behaviours are a major determinant of chronic conditions (Fine, Philogene, Gramling, Coups, & Sinha, 2004). Unhealthy behaviours increase the risk of developing a wide range of health conditions including type 2 diabetes and hypertension, while health-promoting behaviours such as regular exercise are consistently associated with a lower prevalence of chronic conditions (Agborsangaya et al., 2013; Stenholm et al., 2016; Livingstone & McNaughton, 2017). Psychological resources can directly increase engagement in healthy behaviours, i.e. individuals possessing greater levels of psychological resources are more likely to perform health-promoting behaviours (Diener & Chan, 2011; Taylor, Kemeny, Reed, Bower, & Gruenewald, 2000). Grant, Wardle, and Steptoe (2009) found that a high level of life satisfaction was related to not smoking, exercise, and consumption of a healthier diet. Another study found that optimism was a strong predictor of sleep quality (Lau, Hui, Lam, & Cheung, 2017). Psychological resources can also prevent maladaptive coping behaviours such as smoking and overeating by helping individuals adopt adaptive coping strategies when facing adversity (Conversano et al., 2010; Krasikova, Lester, & Harms, 2015). Given that health behaviours are a major predictor of chronic conditions and positively influenced by psychological resources, health behaviours may mediate the association between psychological resources and chronic conditions.

Allostatic load

Allostatic load is the wear and tear on the body representing cumulative dysregulation in multiple physiological systems (Beckie, 2012). It is driven by prolonged activation of stress regulatory systems, resulting from chronic exposure to stress and adversity over the life span (McEwen, 1998). Long-term activation of these systems can lead to physical and mental health issues such as cardiovascular diseases and depressive symptoms (McEwen, 2004; McEwen & Wingfield, 2003). Psychological resources can help individuals perceive less stress by promoting positive relations with others (Segrin & Rynes, 2009), positive reappraisal and a problem-solving approach toward stressful situations, thereby reducing activation of stress regulatory systems and in turn allostatic load (Fogelman & Canli, 2015; Taylor & Broffman, 2011; Wiley et al., 2017). When faced with adversity, individuals with more psychological resources show reduced physiological responses, including lower heart rate, blood pressure and cortisol (Creswell et al., 2005), which contribute to lower allostatic load over time. In one study, psychological resources such as self-acceptance and purpose in life were associated with lower allostatic load (Johansson, Huang, & Lindfors, 2007). Given that allostatic load is a significant determinant of chronic conditions, and that psychological resources can lower stress-related allostatic load biomarkers, allostatic load may mediate the association between psychological resources and chronic conditions.

Current study

The purpose of this study is to investigate the association of psychological resources with the prevalence of chronic conditions 7–10 years later, and the mediating roles of health behaviours and allostatic load. We hypothesise that psychological resources are negatively associated with the prevalence of chronic conditions later in life. Further, we expect that health behaviours and allostatic load will both partially mediate the negative association between psychological resources and the prevalence of chronic conditions.

Method

Sample

The present study is a secondary analysis of data from Midlife in the United States (MIDUS), a national longitudinal study of the role of behavioral and psychosocial factors in health and well-being. Participants were recruited using random digit dialling and were

English-speaking, non-institutionalised adults aged 25–74 living in the U.S. MIDUS surveys consisted of a phone interview and self-administered questionnaires about psychosocial, physical and mental health. The original MIDUS cohort (1995–1996; $N = 7{,}108$) was followed longitudinally, with a second wave of data (MIDUS 2; $N = 4{,}963$) collected in 2004–2006. Participants who completed MIDUS 2 were eligible to participate in a Biomarker Project during 2004–2009 ($N = 1{,}255$). The third wave of data (MIDUS 3; $N = 3{,}294$) was collected in 2013–2014 using the same survey procedures as those for MIDUS 2. Detailed information about sampling procedures and retention rates of the MIDUS cohort are available elsewhere (Radler & Ryff, 2010).

This study's analysis is based on a subsample of individuals aged 34–83 ($N = 850$) who participated in the MIDUS 2 survey (Wave 2), the Biomarker Project (Wave 2-1) and the MIDUS 3 survey (Wave 3). The subsample was not significantly different from the larger MIDUS cohort on most study variables, including sociodemographic characteristics (age, sex, race, education), psychological resources and health characteristics (chronic conditions, exercise), although they were significantly more likely to have a college degree and less likely to smoke (Love, Seeman, Weinstein, & Ryff, 2010).

Measures

Demographics

Demographic variables—age, sex, marital status, race and education—from Wave 2 were examined as control variables. Additionally, chronic conditions assessed at Wave 2 were included in the analysis as a control variable (Table 1).

Psychological resources

Measures of the eight psychological resources assessed at Wave 2 were: the three-item Life Orientation Test-Revised, a measure of dispositional optimism (Scheier &

Table 1. Descriptive statistics of demographics, health behaviours and chronic conditions measures.

Type	Variable description	*N*/Range	Mean (SD) or %
Demographics	Age	34–83	54.73 (11.02)
	Sex (% female)	474	55.8%
	Marital Status (% currently married)	849	72.6%
	Race		
	White	791	93.1%
	Non-White	59	6.9%
	Education		
	Less than high school	25	2.9%
	High school diploma	175	20.6%
	Some college	179	21.1%
	College degree	266	31.2%
	Graduate school and above	205	24.1%
Health Behaviours	Smoking (% never regularly smoked)	0–2	56.7%
	Physical activity (% active)	0–2	56.4%
	Fruits and vegetable consumption (% recommended consumption)	0–2	60.4%
	Fast food consumption (% no consumption)	0–2	16%
	Sleep (% good quality sleep)	0–2	83.8%
	Health Behaviour Index (Sum)	0–10	6.83 (1.6)
Chronic Conditions	Number of chronic conditions (Wave 2)	0–30	2.15 (2.10)
	Number of chronic conditions (Wave 3)	0–30	3.19 (3.01)

Carver, 1985); the seven-item Self-Esteem scale (Rosenberg, 1965); the six-item Positive Affect scale (Mroczek & Kolarz, 1998); the five-item Life Satisfaction scale (Prenda & Lachman, 2001); the seven-item Purpose in Life scale; the seven-item Self-Acceptance scale; the seven-item Positive Relations with Others scale; and the seven-item Environmental Mastery scale (Ryff & Keyes, 1995).

Previous research suggests that psychological resources commonly coexist, are highly inter-correlated, and load on a central psychological resource construct (Hobfoll, 2002). The eight psychological resources used in the present study showed moderate to high correlations (.39 to .76) with each other. Supporting the concept of a central psychological resource construct, principal components analysis suggested that these eight psychological resource scales were described by a single factor (eigenvalue = 4.9, 61.52% of scale variance explained; all factor loadings > .68). Confirmatory factor analysis was then performed, and the eight psychological resources were combined into a single composite variable ($\alpha = .86$) representing an individual's overall level of psychological resources. Model fit indices of the composite variable suggested a good fit (CFI = .988, TLI = .982, RMSEA = .055). Factor loadings of all eight observed resource indicators on the psychological resources latent variable were > .60 (Figure 1).

Health behaviours

Health behaviours were measured at Wave 2-1 using a health behaviour index similar to those in other studies (e.g. Heinrich & Maddock, 2011). This index included five health behaviours, and engagement in each behaviour was categorised into three levels representing unhealthy engagement, moderate engagement and healthy engagement: Sleep (poor, adequate, good sleep quality), physical activity (inactive, lightly active, active), fruit and vegetable consumption (no or little consumption, light consumption, recommended consumption), fast food consumption (more than once per week, less than once per week, no consumption) and smoking (current smoker, former smoker, never smoked). Unhealthy engagement in each behaviour was scored as 0, moderate engagement in each behaviour was scored as 1 and healthy engagement in each behaviour was scored as 2. Scores were summed to represent individuals' overall engagement in health behaviours, and ranged from 0 to 10, with higher scores indicating greater engagement in health-promoting behaviours (Table 1).

Chronic conditions

At Wave 2 and Wave 3, participants were asked whether they been treated/diagnosed for 30 different chronic conditions such as diabetes, hypertension, joint/bone diseases, anxiety/depression and stroke in the past 12 months. The presence of each condition was dichotomised as yes (1) or no (0), and scores for each condition were summed. The possible range for chronic condition scores was 0–30, with higher scores indicating a greater number of chronic conditions (Table 1).

Allostatic load

Consistent with previous studies using the MIDUS cohort, allostatic load indicators were measured at Wave 2-1 and included 23 biomarkers from seven physiological

Table 2. Descriptive statistics and high-risk cut point values for individual biomarkers and the multi-system allostatic load score.

Systems and representative biomarkers	*N*	*M*	SD	High-risk cut point
Cardiovascular System				
Resting SBP (mmHg)	850	130.82	17.51	≥143.00
Resting DBP (mmHg)	850	75.05	10.29	≥82.00
Resting Heart Rate (bpm)	849	70.22	11.03	≥77.00
Metabolic – Lipids System				
Waist-to-Hip Ratio	849	.89	.10	≥.97
Triglycerides (mg/dL)	845	133.29	80.37	≥160.00
HDL Cholesterol (mg/dL)	845	55.00	17.38	≤41.37
LDL Cholesterol (mg/dL)	845	107.47	35.40	≥128.00
Metabolic – Glucose Metabolism System				
Glycosylated Haemoglobin (HbA1c)	840	5.97	.88	≥6.10
Fasting Glucose (mg/dL)	841	100.29	24.42	≥105
Insulin Resistance (HOMA-IR)	841	3.26	3.54	≥4.05
Inflammation System				
CRP (mg/L)	840	2.58	3.77	≥3.18
IL6 (pg/mL)	845	2.59	2.41	≥3.18
Fibrinogen (mg/dL)	840	337.08	80.77	≥390.00
sE-Selectin (ng/Ml)	845	41.08	20.95	≥50.58
sICAM-1 (ng/Ml)	845	282.51	96.45	≥329.65
Sympathetic Nervous System				
Urine Epinephrine (μg/g creatine)	837	2.00	1.25	≥2.54
Urine Norepinephrine (μg/g creatine)	842	27.20	12.45	≥33.33
Hypothalamic Pituitary Adrenal Axis				
Urine Cortisol (μg/g creatine)	842	17.09	27.93	≥21.00
Blood DHEA-S (μg/dL)	849	105.97	76.20	≤51.00
Parasympathetic Nervous System				
SDRR (msec)	795	35.01	17.13	≤23.54
RMSSD	795	21.53	16.92	≤11.83
Low-frequency Spectral Power	795	424.23	614.32	≤113.96
High-frequency Spectral Power	795	276.59	716.79	≤54.16
Allostatic Load Sum Score	845	2.13	1.20	

systems: (1) cardiovascular system (resting systolic blood pressure, resting diastolic blood pressure and resting heart rate), (2) lipid metabolism system (waist-to-hip ratio, triglycerides, high density lipoprotein cholesterol [HDL] and low density lipoprotein cholesterol [LDL]), (3) glucose metabolism system (glycosylated haemoglobin [HbA1c], fasting glucose, and homeostasis model of insulin resistance [HOMA-IR]), (4) inflammation system (C-reactive protein [CRP], Interleukin-6 [IL-6], fibrinogen, sE-Selectin, and soluble intercellular adhesion molecule-1 [sICAM-1]), (5) sympathetic nervous system (urine epinephrine and urine norepinephrine), (6) hypothalamic-pituitary-adrenal system (urine cortisol and blood dehydroepiandrosterone sulphate [DHEA-S]) and (7) parasympathetic nervous system (heart rate variability: standard deviation of R-R intervals [SDRR], root mean square of successive differences [RMSSD], low-frequency spectral power, and high-frequency spectral power).

Allostatic load scores were calculated as the sum of the seven physiological systems as described previously (see Gruenewald et al., 2012; Wiley, Gruenewald, Karlamangla, & Seeman, 2016), according to the following steps. Each biomarker in the system was given a score of 0 or 1, based on being below or above the high-risk cut point value. These scores were summed and divided by the number of biomarkers in each system. Each system score ranged from 0 to 1. System scores were given only for participants with recorded values on at least half of the biomarkers in each system. This method of calculation was repeated for all seven biological systems, and allostatic load scores were calculated for participants with values on at least six of the seven systems. To account for the influence of medications on relevant physiological systems, participants who reported taking prescription medications for cardiovascular health, cholesterol, or diabetes were given a score of 1 for the cardiovascular system, lipid metabolism system, or glucose metabolism system, respectively. Scores for each system were summed to create an allostatic load score ranging from 0 to 7; higher scores indicated greater allostatic load (Table 2).

Statistical analysis

Structural equation modelling (SEM) was performed in Mplus to test the hypothesised model presented in Figure 1. Chronic conditions were specified as a count variable in the analysis and Maximum Likelihood Robust estimator was used, which is robust to violations of normality including skewness (Muthén & Muthén, 1998). Since the MIDUS cohort includes twin pairs and siblings, family clustering was added to account for the violation of independence. One participant was missing health behaviour index scores, and five participants were missing allostatic load scores. The model tested the direct association of psychological resources at Wave 2 and the indirect associations via health behaviours and allostatic load at Wave 2-1 with chronic conditions at Wave 3. Age, sex, marital status, race, education, and number of chronic conditions at Wave 2 were included in the model as covariates.

Results

Table 3 presents bivariate correlations among study variables. Among primary variables in the main analysis, psychological resources were positively associated with health behaviours and negatively associated with Wave 3 chronic conditions. Health behaviours were negatively associated with allostatic load and Wave 3 chronic conditions, and allostatic load was positively associated with Wave 3 chronic conditions.

Figure 1 shows standardised regression coefficients among variables in the SEM. Psychological resources at Wave 2 were positively associated with health behaviours at Wave 2-1; however, no significant association was found between psychological resources and allostatic load. Health behaviours at Wave 2-1 were negatively associated with chronic conditions at Wave 3, and allostatic load at Wave 2-1 was positively

Table 3. Correlations among study variables.

	1	2	3	4	5	6	7	8	9
1. Age	–								
2. Sex	.031	–							
3. Marital status	.059	.130***	–						
4. Race	.083*	.010	.082*	–					
5. Education	–.097**	.084*	–.011	.037	–				
6. M2 chronic conditions	.080*	–.193***	–.087*	–.013	–.081*	–			
7. Psychological resources	.256***	.032	.173***	.053	.116**	–.300***	–		
8. Health behaviours	.107**	–.054	.068*	.053	.188**	–.138***	.216***	–	
9. Allostatic load	.438***	.057	.044	–.028	–.134**	.173***	.055	–.115**	–
10. M3 chronic conditions	.088**	–.149***	–.059	–.047	–.109**	.551***	–.234***	–.189***	.193***

Note: Sex (female = 0, male = 1); Marital status (not married = 0, married = 1); Race (non-white = 0, white = 1). $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

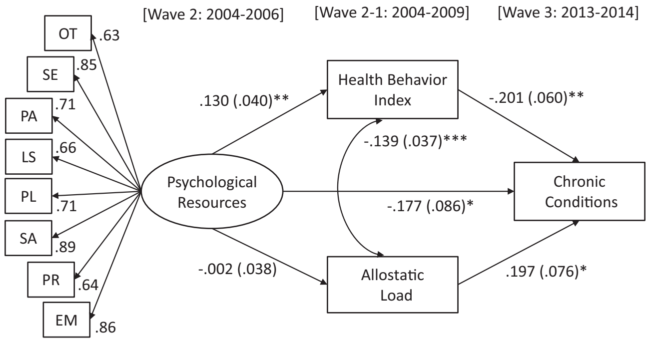

Figure 1. Results from the hypothesised model testing. Standardised coefficients (standard errors) are shown above. Akaike (AIC) = 42,328, Bayesian (BIC) = 42,651. Demographic variables were included in the model as covariates. OT = optimism, SE = self-esteem, PA = positive affect, LS = life satisfaction, PL = purpose in life, SA = self-acceptance, PR = positive relations with others, EM = environmental mastery. Note: $^*p < .05$; $^{**}p < .01$; $^{***}p < .001$.

associated with chronic conditions at Wave 3. There was a negative association between health behaviours and allostatic load.

As hypothesised, psychological resources at Wave 2 had a direct association with chronic conditions at Wave 3. Health behaviours at Wave 2-1 partially mediated the association between psychological resources and chronic conditions (b for indirect effect $= -.026$, SE $= .011$, $p < .05$). Allostatic load at Wave 2-1 did not mediate the association between psychological resources and chronic conditions (b for indirect effect $= -.000$, SE $= .008$, $p > .05$).

Discussion

The findings of this study highlight the importance of psychological resources and their positive influence on chronic conditions, and suggest directions for future research. Individuals reporting more psychological resources had a lower prevalence of chronic conditions after 7–10 years while controlling for baseline chronic conditions and demographic variables. This association was partially mediated by health behaviours, but not by allostatic load. The finding of a direct beneficial association between psychological resources and subsequent chronic conditions builds on prior longitudinal research. Life satisfaction has been found to protect against cardiometabolic conditions 8–11 years later (Boehm, Chen, Williams, Ryff, & Kubzansky, 2016), positive affect has been negatively associated with a 10-year incidence of coronary heart disease (Davidson, Mostofsky, & Whang, 2010), and higher self-esteem has predicted a lower prevalence of depression and anxiety later in life (Sowislo & Orth, 2013). Yet, evidence linking a composite variable of psychological resources to chronic conditions has been limited. The present study addressed that gap, finding that individuals with a large reservoir of psychological resources had fewer chronic conditions later in life.

Health behaviours partially mediated the association between psychological resources and chronic conditions, such that individuals who had more psychological resources had greater engagement in health-promoting behaviours, which in turn contributed to a lower prevalence of chronic conditions later in life. In previous studies, optimism has been associated with sustained physical activity (Progovac et al., 2017), and positive affect has been related to better sleep habits and greater fruit and vegetable consumption (Steptoe, O'Donnell, Marmot, & Wardle, 2008; White, Horwath, & Conner, 2013). Also, life satisfaction was predictive of 10-year behavioral cardiovascular risk factors (Łopuszańska, Szklarska, Lipowicz, Jankowska, & Kozieł, 2013). The mediating role of health behaviours in the present study supports previous research demonstrating that psychological resources influence health behaviours, which in turn impact health conditions (Gallo & Matthews, 2003; Matthews & Gallo, 2011). The present study showed the beneficial influence of psychological resources on health behaviours up to 3–5 years later, and health behaviours on chronic conditions 7–10 years later, advancing the research linking psychological resources to subsequent chronic conditions via health behaviours.

Allostatic load was not a significant mediator between psychological resources and chronic conditions. This null finding was due to psychological resources not being associated with allostatic load at Wave 2-1, which did not support our hypothesis. Although some previous research has found evidence that psychological resources were associated with allostatic load (Glei, Goldman, Chuang, & Weinstein, 2007; Seeman, Stein-Merkin, Karlamangla, Koretz, & Seeman, 2014), this association did not emerge in the present study. Several longitudinal and cross-sectional studies have reported significant associations between a single psychosocial resource and allostatic load (Hernandez et al., 2015; Ryff et al., 2006), but there is a lack of research demonstrating effects of composite psychological resources on allostatic load. Additionally, according to a meta-analysis, the association between psychological resources and allostatic load depends on other sociodemographic contexts such as socioeconomic status, social integration and neighbourhood poverty (Wiley et al., 2017). The absence of an association between psychosocial resources and allostatic load in the present study may indicate a need for more comprehensive measurement of such social and environmental moderators. Nonetheless, in the present study, individuals with lower allostatic load had a lower prevalence of chronic conditions later in life, which is consistent with prior research supporting allostatic load as a major predictor of chronic conditions, including hypertension, type 2 diabetes and arthritis (Beckie, 2012; Mattei, Demissie, Falcon, Ordovas, & Tucker, 2010).

Results of this study should be considered in light of several limitations. First, the MIDUS cohort is not representative of the U.S. population, with a limited number of individuals from racial and ethnic minority groups. Most participants were white and well-educated, so the study findings may not generalise to racially/ethnically diverse and low socioeconomic status populations. Second, this study's outcome was a sum score of chronic conditions, which does not capture the severity of functional limitations. One severe chronic condition may cause serious restrictions in activities of daily living while two or three minor chronic conditions may not cause limitations in activities of daily living. Given that functional limitations may better reflect health in an aging population than simply the number of chronic conditions, future research should examine measures of quality of life in addition to traditional disease outcomes. Additionally, the current study explored associations between psychological resources and the prevalence—rather than the development—of chronic conditions later in life. Therefore, causality between psychological resources and chronic conditions cannot be ascertained. However, baseline chronic conditions were controlled for in the model, and a temporal precedence of nearly a decade between the psychological resources survey and Wave 3 chronic condition measurements provides more compelling evidence for the observed beneficial associations than does a cross-sectional study.

Lastly, the contribution of chronic conditions to other study variables is unclear. Individuals may have had lower levels of psychological resources because they had chronic conditions, and it is also possible that individuals may have engaged in more health-promoting behaviour in response to being diagnosed with one or more chronic conditions. Moreover, individuals' level of psychological resources may fluctuate over time, and it is unclear how changes in psychological resources would influence development and severity of health outcomes. These limitations may suggest a need to examine subgroups who behave differently when diagnosed with chronic conditions, and future research to establish causality between psychological resources and chronic conditions.

Despite these limitations, the present study contributes significantly to our understanding of mechanisms by which psychological resources play a beneficial role with respect to chronic conditions. To our knowledge, this is the first study to longitudinally investigate the mediating roles of health behaviours and allostatic load in the association between psychological resources and chronic conditions. Findings of the present study show that psychological resources are a meaningful predictor of health outcomes, and that psychological resources contribute to a strong foundation for physical and mental health across the lifespan. Future research should examine whether these findings generalise to a diverse population, and explore other potential mechanisms linking psychological resources to health outcomes.

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