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Psychological Resources and Glucoregulation in Japanese Adults: Findings From MIDJA

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Objective: To examine associations between glucoregulation and 3 categories of psychological resources: hedonic well-being (i.e., life satisfaction, positive affect), eudaimonic well-being (i.e., personal growth, purpose in life, *ikigai*), and interdependent well-being (i.e., gratitude, peaceful disengagement, adjustment) among Japanese adults. The question is important given increases in rates of type 2 diabetes in Japan in recent years, combined with the fact that most prior studies linking psychological resources to better physical health have utilized Western samples. ***Method:*** Data came from the Midlife in Japan Study involving randomly selected participants from the Tokyo metropolitan area, a subsample of whom completed biological data collection (N = 382; 56.0% female; $M(SD)_{\text{age}}$ = 55.5(14.0) years). Glycosylated hemoglobin (HbA1c) was the outcome. Models adjusted for age, gender, educational attainment, smoking, alcohol, chronic conditions, body mass index (BMI), use of antidiabetic medication, and negative affect. ***Results:*** Purpose in life ($\beta = -.104$, $p = .021$) was associated with lower HbA1c, and peaceful disengagement ($\beta = .129$, $p = .003$) was associated with higher HbA1c in fully adjusted models. Comparable to the effects of BMI, a 1 standard deviation change in well-being was associated with a .1% change in HbA1c. ***Conclusions:*** Associations among psychological resources and glucoregulation were mixed. Healthy glucoregulation was evident among Japanese adults with higher levels of purpose in life and lower levels of peaceful disengagement, thereby extending prior research from the United States. The results emphasize the need for considering sociocultural contexts in which psychological resources are experienced in order to understand linkages to physical health.

Keywords: hedonic well-being, eudaimonic well-being, glucoregulation, cultural psychology, glycosylated hemoglobin

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The health benefits associated with psychological well-being are well-documented. Across multiple health outcomes and indices of psychological well-being, evidence supports positive psychological functioning as predictive of better health, including lower morbidity and mortality (Boehm & Kubzansky, 2012; Chida & Steptoe, 2008; Kim, Park, Sun, Smith, & Peterson, 2014; Kim, Strecher, & Ryff, 2014; Kim, Sun, Park, Kubzansky, & Peterson, 2013; Kim, Sun, Park, & Peterson, 2013; Pressman & Cohen, 2005). Importantly, salubrious effects stem from the presence of well-being, and not simply the absence of psychological ill-being, such as depression or anxiety (Keyes, 2002). However, most prior research has utilized samples from the United States and other Western European countries. Therefore, it is unknown whether these results extend to other cultural contexts, where well-being may have different meanings and possibly unique linkages to health. To address these issues, we examined associations between several varieties of psychological well-being and a marker of glucoregulation in a large sample of Japanese adults.

Psychological well-being is not a unitary construct, but rather is multidimensional and includes both hedonic and eudaimonic dimensions (Keyes, Shmotkin, & Ryff, 2002; Ryan & Deci, 2001). Hedonic well-being is characterized by pleasure-seeking and happiness and is typically measured with scales of positive affect, happiness, and life satisfaction. Eudaimonic well-being, in contrast, concerns self-realization and thriving via pursuit of meaningful goals and experiences of personal growth and development (Keyes et al., 2002; Ryan & Deci, 2001). Both broad types of well-being reflect Western conceptions, although we note that in

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Japan, enhanced longevity has been associated with the concept of *ikigai*, which translates roughly to having a reason for being and thus is conceptually similar to purpose or meaning in life. Across three large samples, Japanese individuals who report having *ikigai* had lower mortality rates (Cohen, Bavishi, & Rozanski, 2016; Koizumi, Ito, Kaneko, & Motohashi, 2008; Sone et al., 2008; Tanno et al., 2009). As an interdependent culture (Markus & Kitayama, 1991, 2010), other aspects of well-being in Japan involve showing understanding and concern for others so as to promote social harmony and connectedness (Uchida, Norasakkunkit, & Kitayama, 2004). Experiences of gratitude and appreciation for simply being alive and peaceful disengagement from a continually changing and confusing reality emerged as two factors of minimalist well-being that are distinct among Japanese adults (Kan, Karasawa, & Kitayama, 2009). Well-being in Japan also involves adjusting and orienting to others (Kitayama & Markus, 2000; Ryff et al., 2014).

In the current study, we focus on glycosylated hemoglobin (HbA1c), as the primary indicator of glucoregulation and physical health. HbA1c is used as a diagnostic criterion for type 2 diabetes, which constitutes a major public health burden, affecting over 240 million people and hundreds of billions of dollars worldwide (van Dieren, Beulens, van der Schouw, Grobbee, & Neal, 2010). Japan has the fifth largest population of diabetics in the world, and its rates of type 2 diabetes are increasing at an alarming rate (International Diabetes Federation, 2013; Morimoto, Nishimura, & Tajima, 2010). Elevated HbA1c is also a risk factor for other adverse health outcomes, including cardiovascular disease, cancer, and all-cause mortality, independent of diabetes status (de Beer & Liebenberg, 2014; Khaw et al., 2004).

The modest literature linking well-being to HbA1c has yielded mixed results, with many studies finding null associations with hedonic (Paschalides et al., 2004) and eudaimonic well-being (Bradshaw et al., 2007; Feldman & Steptoe, 2003; Ryff et al., 2006). However, in a sample of older women, positive affect predicted lower (i.e., healthier) HbA1c over a 2-year follow up, controlling for baseline HbA1c, and purpose in life and personal growth were protective against increases in HbA1c for those of low socioeconomic status (Tsenkova, Love, Singer, & Ryff, 2007). More recently, perceived control was cross-sectionally associated with lower HbA1c in a national sample of older adults (Infurna & Gerstorf, 2014). Hedonic and eudaimonic well-being were both cross-sectionally and prospectively associated with lower risk of metabolic syndrome within the Midlife in the U.S. (MIDUS) national sample, although associations were driven primarily by waist circumference and lipids, and not with glucoregulation (Boylan & Ryff, 2015). Other findings from MIDUS demonstrated that life satisfaction was associated with lower incident cardiometabolic conditions as well as lower cardiometabolic risk scores, measured with a composite of biomarkers that included HbA1c (Boehm, Chen, Williams, Ryff, & Kubzansky, 2016). Additionally, purpose in life was associated with healthier allostatic load profiles, including a marginal association with a composite measure of glucoregulation (Zilioli, Slatcher, Ong, & Gruenewald, 2015).

The current inquiry examines cross-sectional associations between HbA1c and three categories of psychological resources: hedonic well-being (i.e., positive affect, life satisfaction), eudaimonic well-being (i.e., personal growth, purpose in life, and *ikigai*), and interdependent well-being (i.e., peaceful disengagement, gratitude, adjustment; Kan et al., 2009; Kitayama, Karasawa, Curhan, Ryff, & Markus, 2010). Based on prior literature, we hypothesized that eudaimonic well-being, especially *ikigai* and purpose in life, would predict lower levels of HbA1c. We hypothesized that hedonic well-being would not be associated with HbA1c given prior evidence that positive emotions are less valued and experienced less frequently in East Asian cultures, such as Japan, compared with the United States (Bastian, Kuppens, De Roover, & Diener, 2014; Miyamoto & Ma, 2011). For our final category of interdependent well-being, we speculated that these psychological resources might also predict better glucoregulation, although no prior studies have examined such associations and as such, these associations should be interpreted as preliminary.

Although the primary focus of the study was on varieties of well-being and glucoregulation, supplemental analyses examined associations between well-being and three other cardiovascular risk factors (systolic blood pressure, ratio of total to HDL cholesterol, and waist circumference). These were done to facilitate comparisons with previously published findings of well-being and metabolic syndrome and other measures of cardiometabolic risk and allostatic load in the United States (Boehm et al., 2016; Boylan & Ryff, 2015; Zilioli et al., 2015). Lack of comparability in multiple areas of assessment (i.e., lack of fasting glucose, less comprehensive measurement of physical activity, and additional well-being measures of interest) precluded conducting exactly the same set of analyses in Japan.

Method

Sample

Data came from the biological subsample of the Midlife in Japan (MIDJA) study (N = 382; 56% female). The MIDJA survey sample was recruited in 2008 to proportionately reflect the 23 neighborhood wards in Tokyo, stratified by age and gender (N = 1,027; 50.8% female; age range = 30–79 years). Biological data (i.e., blood and urine) were collected from 37.2% of the MIDJA survey sample at a medical clinic near the University of Tokyo with timing in accordance with participant convenience. Eligibility criteria for the biomarker project included completing the initial survey and expressing interest in the biomarker phase by returning a postcard to the survey research firm. 72.3% of individuals who returned the postcard provided valid biological data (see Ryff et al., 2016 for complete study details). The participants who participated in the biomarker study (n = 382) were very similar to those who did not participate (n = 645) on demographic variables (age, educational attainment, family size, home ownership, employment status; $ps > .30$), although a significantly higher proportion of women participated in the biomarker study (p = .010) and there was a trend that married individuals also had greater participation in the biomarker study (p = .052). The health characteristics of the biomarker sample were also similar to the survey sample in terms of number of chronic conditions, number of prescription medications taken, and number of physician visits in the prior year ($ps >$ .10). The biomarker sample, however, had marginally better subjective physical health (p = .10), was less likely to smoke (p = .004) and had lower scores on assessments of instrumental and basic activities of daily living as compared to those who did not participate in the biomarker study ($ps < .01$).

We also drew on data from the second wave of the Midlife in the United States (MIDUS) study to compare associations between psychological resources and HbA1c and other cardiovascular risk factors within the United States and Japan. (Brim, Ryff, & Kessler, 2004; Radler & Ryff, 2010). We interpret the extent to which these associations were similar in magnitude to represent cultural similarities, whereas different associations between psychological resources and HbA1c and cardiovascular risk within the United States and Japan represented cultural-specific associations. MIDUS respondents were initially recruited in 1995 and 1996 via random digit dialing. The second wave of the study began in 2004, and biological data collection occurred 2004 through 2009. The biological sample was comparable to the survey sample on most demographic and health covariates, although the biological sample was better educated and less likely to smoke than the survey sample (Love, Seeman, Weinstein, & Ryff, 2010). To facilitate comparisons with Boylan and Ryff (2015), only the participants from the national study were included (i.e., data from the city-specific sample of African Americans from Milwaukee, WI was excluded).

Psychological Resource Measures

Eudaimonic well-being. All psychological resource measures were assessed as part of the MIDJA survey. Eudaimonic well-being was assessed based on Ryff's theoretical model (Ryff & Keyes, 1995; Ryff, 1989) with two scales: Personal Growth (e.g., "For me, life has been a continuous process of learning, changing, and growth") and Purpose in Life (e.g., "I have a sense of direction and purpose in life"). Each scale had seven items, and internal consistency was .74 for personal growth and .56 for purpose in life. Respondents also answered yes or no to whether or not they had *ikigai* in their life.

Hedonic well-being. Hedonic well-being was assessed via positive affect and life satisfaction. Positive affect was an average rating of how much of the time respondents felt, "cheerful," "in good spirits," "extremely happy," "calm and peaceful," "satisfied," and "full of life" in the last 30 days on a four-point scale ($\alpha = .93$; Mroczek & Kolarz, 1998). The life satisfaction scale contained five items (e.g., "If I could live my life over, I would change almost nothing") and was rated on a seven-point scale (1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .89$; Diener, Emmons, Larsen, & Griffin, 1985).

Interdependent well-being. Eastern conceptions of well-being were assessed via gratitude (e.g., "I feel grateful that I am alive;" $\alpha = .79$) and peaceful disengagement scales (e.g., "It feels good to do nothing and relax;" $\alpha = .68$). Items were rated on a seven-point scale, and each scale contained five items (Kan et al., 2009). The adjustment scale assessed how individuals viewed themselves as linked to others (e.g., "When values held by others sound more reasonable, I can adjust my values to theirs."). The adjustment scale had five items, which were rated on a seven-point scale ($\alpha = .63$).

Glycosylated Hemoglobin (HbA1c)

Whole blood was collected and analyzed in Tokyo to determine HbA1c using a latex agglutination assay (Showa Medical Service Co. LTD). Over 95% of biological samples were obtained between 0900 and 1145, with most of the remainder by 1330, and just eight in the afternoon by 1530. The interassay coefficient of variance was 10%. Fasting glucose was not available in the MIDJA cohort.

Additional Cardiovascular Risk Factors

Systolic blood pressure was measured by clinic staff three times in a seated position following a 5-min resting period. At least 30 s passed between blood pressure readings. The second and third blood pressure readings were averaged as the outcome variable. For cholesterol assays, blood samples were collected, and frozen aliquots were shipped to Madison, WI for processing by Meriter Labs (Madison, WI), using a Cobas Integra analyzer (Roche Diagnostics, Indianapolis, IN). Waist circumference was measured by clinic staff at the narrowest point between the ribs and the iliac crest to the nearest millimeter.

Covariates

Sociodemographic factors, health behaviors, and health status were included in models linking psychological resources and HbA1c to account for confounding influences and relevant mediating behavioral pathways. Specifically, age, gender, educational attainment (years completed), current smoking status, alcohol consumption (number of drinks per week), physical activity (dichotomized as ever (v. never) using exercise or movement therapy within the last 12 months, healthy eating (sum of high fat meat (reverse coded), fish, protein, fruit, vegetable, and sugared beverage (reverse coded) consumption; Levine et al., 2016), subjective sleep quality (4 response categories ranging from very good (coded 0) to very bad (coded 3); Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), body mass index (BMI; [weight (kilograms)/height squared (meters)], measurements taken by clinic staff), self-reported number of chronic conditions, excluding diabetes (out of 29 possible), and use of antidiabetic medication were included as control variables. Negative affect (Mroczek & Kolarz, 1998) was also included as a control variable in order to assess the relative independence among psychological resources and general negative affectivity. Negative affect was measured on a five-point scale (1 = *none of the time*, 5 = *all of the time*) as the mean of responses to six items asking how much of the time participants felt "so sad nothing could cheer you up," "nervous," "restless or fidgety," "hopeless," "that everything was an effort," and "worthless" during the last 30 days.

Statistical Analyses

Hierarchical linear regression models were employed to examine associations between psychological resources and HbA1c. HbA1c and weekly alcohol consumption (+1) were log10 transformed to account for non-normality. Sociodemographic covariates and psychological resources were entered in the first step of the regression model, and then the health behaviors and health factor covariate measures were entered on the next step. Negative affect was entered on the final step of the regression model. Each resource measure was entered in a separate regression, and the relative contributions of significant resources were examined in a later analysis, adjusting for all covariates and negative affect. All continuous variables were *z*-scored prior to entry in the regression model and can be interpreted in standard deviation units.

Additional analyses were also run to test associations between well-being and three additional cardiovascular risk factors as outcomes, including systolic blood pressure, total to HDL cholesterol ratio (log10 transformed), and waist circumference. Covariates were identical to the models predicting HbA1c. Cultural differences in the link between well-being and HbA1c for a subset of well-being measures (personal growth, purpose in life, positive affect, life satisfaction, and adjustment) were tested with culture (United States v. Japan) by well-being interaction terms predicting HbA1c in a combined sample of MIDJA and MIDUS respondents.

Results

Descriptive information on the sample, including bivariate correlations between study variables and HbA1c, are presented in Table 1. Men, compared to women, were significantly more educated, had higher BMI, were more likely to be currently smoking, consumed more alcohol, had higher subjective sleep quality and had lower scores on the healthy eating index, positive affect, personal growth, gratitude, and peaceful disengagement. Preliminary analyses revealed no gender differences in the associations between psychological resources and HbA1c ($ps > .15$), so both genders are included in the same models. HbA1c was positively correlated with age, BMI, and antidiabetic medication use and negatively correlated with personal growth and purpose in life in bivariate analyses.

Table 2 presents results from the regression models predicting HbA1c. Each psychological resource variable was entered in a separate model. Adjusting for all covariates (Model 2), including age, gender, education, BMI, current smoking, alcohol consumption, exercise, healthy eating, subjective sleep quality, chronic conditions, and antidiabetic medication use, purpose in life ($\beta = -.104$, $t(340) = 2.33$, $p = .021$) was associated with lower HbA1c and peaceful disengagement was associated with higher HbA1c ($\beta = .129$, $t(340) = 2.99$, $p = .003$). These effects remained significant with negative affect added to the model (purpose in life: $\beta = -.108$, $p = .018$; peaceful disengagement: $\beta = .130$, $p = .003$). When purpose in life and peaceful disengagement were entered simultaneously in a fully adjusted regression model, both purpose in life ($\beta = -.093$, $p = .041$) and peaceful disengagement ($\beta = .120$, $p = .006$) remained significant predictors of HbA1c. No significant interactions between culture and well-being were evident in the combined sample of MIDJA and MIDUS respondents ($ps > .12$).

As an index of relative effect size, predicted HbA1c values at one standard deviation above and below the mean on the two significant well-being variables were compared to predicted HbA1c values for BMI. Results are graphed in Figure 1. Predicted HbA1c at one standard deviation above the mean on purpose in life was approximately .1% lower than at one standard deviation below

Table 1
Descriptive Information on Study Sample

Characteristic	*M* (*SD*) or %			Gender *p*	*r* with HbA1c
	Total ($N = 382$)	Men ($n = 168$)	Women ($n = 214$)		
Age (years)	55.5 (14.0)	56.7 (14.0)	54.5 (14.0)	.13	.366*
Education (years)	13.5 (2.4)	14.0 (2.6)	13.1 (2.1)	.001	−.063
HbA1c (%)	5.7 (.5)	5.8 (.6)	5.7 (.4)	.059	
Systolic blood pressure (mmHg)	121.6 (19.9)	127.3 (19.0)	117.2 (19.6)	<.001	.280*
Ratio total/HDL cholesterol	3.1 (1.1)	3.6 (1.3)	2.8 (.8)	<.001	.292*
Waist circumference (cm)	76.2 (9.8)	83.3 (8.3)	70.5 (6.7)	<.001	.277*
Body mass index	22.6 (3.0)	23.7 (2.9)	21.7 (2.7)	<.001	.260*
Current smoking	21.5%	33.3%	12.1%	<.001	.024
Alcohol (drinks/week)	7.2 (11.8)	11.0 (10.7)	4.2 (11.7)	<.001	−.020
Exercise (% never in last 12 mo.)	55.2%	58.9%	52.3%	.36	.009
Healthy eating index (*z*-score)	.0 (1.0)	−.22 (1.0)	.18 (.9)	<.001	.049
Subjective sleep quality	1.2 (.7)	1.1 (.6)	1.2 (.7)	.010	−.028
Chronic conditions	2.3 (2.0)	2.2 (2.0)	2.4 (2.1)	.38	.081
Anti-diabetic medication use	2.9%	3.6%	2.3%	.47	.506*
Eudaimonic well-being					
Personal growth	34.4 (5.5)	33.8 (5.4)	34.9 (5.6)	.050	−.114*
Purpose in life	32.3 (5.3)	32.0 (5.5)	32.6 (5.2)	.26	−.142*
Ikigai (% yes)	68.1%	117/153	143/194	.56	−.071
Hedonic well-being					
Positive affect	3.3 (.7)	3.2 (.7)	3.4 (.8)	.023	.069
Life satisfaction	4.2 (1.2)	4.1 (1.2)	4.2 (1.2)	.23	−.010
Interdependent well-being					
Gratitude	26.4 (4.6)	25.8 (4.3)	26.9 (4.7)	.023	−.056
Peaceful disengagement	23.0 (4.7)	22.3 (4.6)	23.6 (4.7)	.005	.080
Adjustment	4.3 (.7)	4.2 (.7)	4.4 (.7)	.040	.068
Negative affect	1.7 (.6)	1.6 (.6)	1.8 (.7)	.082	−.046

Note. The *p* value reflects gender difference based on independent samples *t* test or chi-square test for categorical variables. Glycosylated hemoglobin (HbA1c) mass index and ratio of total to HDL cholesterol were log transformed for bivariate correlation analyses.
* $p < .05$.

Table 2
Linear Regression Models With Well-Being Predicting HbA1c as Outcome

	Model 1 demographics			Model 2 + Health factors			Model 3 + Negative affect		
	B (*SE*)	β	*p*	*B* (*SE*)	β	*p*	*B* (*SE*)	β	*p*
Age	.014 (.002)	.39	<.001	.013 (.002)	.36	<.001	.013 (.002)	.36	<.001
Gender (1 = Female)	−.003 (.004)	−.04	.39	.002 (.004)	.02	.69	.002 (.004)	.02	.68
Education (years)	.001 (.002)	.04	.51	.002 (.002)	.05	.31	.002 (.002)	.05	.31
Body mass index				.004 (.002)	.11	.021	.004 (.002)	.11	.024
Current smoking[a]				.001 (.004)	.01	.77	.001 (.004)	.01	.76
Alcohol (drinks/wk)				.000 (.002)	−.01	.89	.000 (.002)	−.01	.88
Exercise[a]				.001 (.001)	.03	.52	.001 (.001)	.03	.53
Healthy eating index				−.003 (.002)	−.07	.15	−.003 (.002)	−.07	.15
Subjective sleep quality				−.001 (.002)	−.02	.59	−.001 (.002)	−.02	.63
Chronic conditions				.000 (.002)	−.01	.77	.000 (.002)	−.01	.86
Anti-diabetic medication use[a]				.097 (.009)	.45	<.001	.097 (.009)	.45	<.001
Negative affect							.001 (.002)	−.01	.84
Eudaimonic well-being									
Personal growth	−.003 (.002)	−.10	.058	−.001 (.002)	−.02	.65	−.001 (.002)	−.02	.61
Purpose in life	−.005 (.002)	−.14	.005	−.004 (.002)	−.10	.021	−.004 (.002)	−.11	.018
Ikigai[a]	−.006 (.004)	−.08	.13	−.005 (.004)	−.06	.16	−.005 (.004)	−.07	.16
Hedonic well-being									
Positive affect	.001 (.002)	.04	.41	.002 (.002)	.05	.26	.002 (.002)	.06	.25
Life satisfaction	−.001 (.001)	−.04	.45	−.001 (.001)	−.04	.66	−.001 (.001)	−.02	.66
Interdependent well-being									
Gratitude	−.002 (.002)	−.05	.32	.000 (.002)	.00	.97	−.000 (.002)	.00	.99
Peaceful disengagement	.005 (.002)	.13	.009	.005 (.002)	.13	.003	.005 (.002)	.13	.003
Adjustment	.001 (.002)	.02	.73	.000 (.002)	.00	.94	.000 (.002)	.01	.91

Note. Each psychological well-being variable was entered in a separate model. Glycosylated hemoglobin (HbA1c) and alcohol were log10 transformed. All continuous predictor variables are *z*-scored.
[a] 1 = yes.

the mean. Predicted HbA1c at one standard deviation above the mean on peaceful disengagement was approximately .1% higher than at one standard deviation below the mean. Effects were comparable to BMI.

As shown in Table 1 in the online supplemental materials, no significant associations were found between well-being and systolic blood pressure, total to HDL cholesterol ratio, or waist circumference (*p*s >.17), with the exception that individuals who endorsed having *ikigai* in their life had lower systolic blood pressure in fully adjusted models ($\beta = -.089$, $t(309) = 2.00$, $p = .047$). Those who endorsed having *ikigai* had estimated systolic blood pressure 3.8 mmHg lower than those reporting no *ikigai* in their lives.

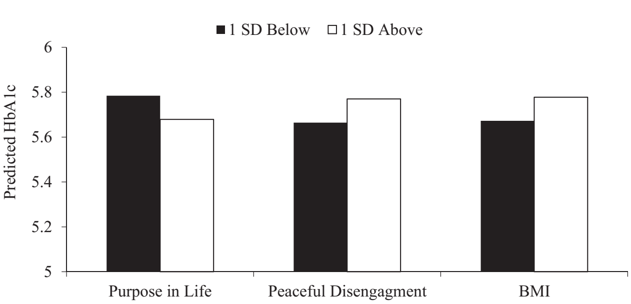

Figure 1. Predicted Glycosylated Hemoglobin (HbA1c) values at one standard deviation above and below the mean of purpose in life, perceived disengagement, and body mass index (BMI) in fully adjusted models.

Discussion

Type 2 diabetes is a major public health concern in Japan, which has the fifth largest population of diabetics in the world and rates of Type 2 diabetes that are increasing over time (International Diabetes Federation, 2013; Morimoto et al., 2010). As such, understanding the role of psychological factors, as possible risk or protective influences on glucoregulation in Japanese adults, is important work to do, given that such factors have accounted for variation in biological risk factors, including those pertinent to type 2 diabetes and cardiovascular disease, in the United States and Europe. The purpose of the current study was to examine associations between three varieties of psychological well-being and an index of glucoregulation (i.e., HbA1c) among Japanese adults. Although associations among psychological resources and glucoregulation were mixed, select outcomes emerged that contribute to the growing body of literature linking psychological resources to objectively assessed measures of health risk.

A first key finding was that purpose in life was associated with better glucoregulation (i.e., lower HbA1c) among Japanese adults, independent of health factors and negative affect. This finding is in line with prior evidence supporting health protective effects of this construct in Western samples. In prior research, individuals with greater purpose in life prospectively demonstrated reduced risk of stroke, myocardial infarction, metabolic syndrome, cerebral infarcts, Alzheimer's disease pathology, and mortality and also increased use of preventative health services (Boehm & Kubzansky, 2012; Boylan & Ryff, 2015; Boyle et al., 2012; Cohen et al., 2016; Hill & Turiano, 2014; Kim et al., 2013, 2014; Ryff et al., 2014; Yu et al., 2015). Purpose in life has been linked with healthier automatic emotion regulation strategies (Schaefer et al., 2013) and sustained activity in reward circuitry (Heller et al., 2013), which may function as neural mechanisms linking purpose in life to physical health outcomes. Given the specificity of the inverse association between HbA1c to purpose in life, this construct may be ubiquitously protective across a number of physical health domains, and efforts to increase purpose in life, perhaps via volunteering or finding work in retirement (Barron et al., 2009; Greenfield & Marks, 2004; Weiss, Bass, Heimovitz, & Oka, 2005), may yield important physical health benefits across cultural contexts. In contrast to protective findings for mortality in Eastern cultural contexts (Koizumi et al., 2008; Sone et al., 2008; Tanno et al., 2009), we did not find evidence linking *ikigai* to glucoregulation. This may have stemmed from the limited assessment of *ikigai* with a yes or no response, although the same measure was linked with reduced systolic blood pressure among Japanese adults.

Although positive affect and life satisfaction (indicators of hedonic well-being) have been shown to predict positive health outcomes in Western samples (Boehm & Kubzansky, 2012; Pressman & Cohen, 2005), we did not expect to see, and did not find, such effects in Japan. East Asians, we noted earlier, are more likely to idealize low arousal positive emotions to high arousal positive emotions (Tsai, 2007). The positive affect scale used in this study included both low (e.g., "calm" and "peaceful") and high (e.g., "extremely happy") arousal adjectives, neither of which were significant predictors of HbAlc. Positive emotions are construed differently in Eastern and Western cultures. Dialectical beliefs are more common among East Asians, which involves to attending to negative aspects of positive emotions (Miyamoto & Ryff, 2011; Uchida et al., 2004). Experimental research supports that East Asians are more likely to believe that being too happy has negative consequences, for example (Miyamoto & Ma, 2011). Reflecting such dialectical beliefs, the links between positive emotions and mental and physical health have been shown to be weaker among Asian samples than among Western samples (Leu, Wang, & Koo, 2011), including between MIDJA and MIDUS respondents (Yoo, Miyamoto, Rigotti, & Ryff, 2016). Thus, the lack of association between hedonic well-being and health outcomes in Japan in the present study is in line with these prior findings. Together, the results support that expectations regarding the function of positive emotions and the cultural contexts in which they occur are relevant for understanding linkages to health.

Because well-being in Japan is likely to involve more interdependent aspects of well-being, we included three Eastern assessments of well-being. These included gratitude, adjustment to others, and peaceful disengagement. Only the latter was associated with HbAlc levels, albeit contrary to the direction we had predicted: higher peaceful disengagement was associated with higher, rather than lower, HbA1c levels. Peaceful disengagement is a component of minimalist well-being that reflects separating the self from the constantly changing reality (Kan et al., 2009). Example items include, "I feel free when I spend all my time just for myself" and "I am satisfied with the time to laze away." As such, disengagement may capture a failure to attend to health concerns and participate in self care, which could contribute to poorer glucoregulation. However, the association remained significant after adjustments for health behaviors and health status factors, such as smoking, healthy eating, sleep, alcohol consumption, and obesity (i.e., BMI), were taken into account, thereby undermining this interpretation. Alternatively, within a highly interdependent culture like Japan, peaceful disengagement may interfere with meeting social obligations and reflect social isolation, which could create other kinds of stress. Considering peaceful disengagement in the context of social responsibilities and resources may be a fruitful direction for future research. Indeed, tangible resources like social status and social relationships have shown to be relevant predictors of health in Japan (Curhan et al., 2014; Murata et al., 2005; Yuasa et al., 2012).

In the present study, having high purpose in life and peaceful disengagement was associated with approximately a 0.1% change in HbA1c from counterparts with low well-being. This effect was comparable to that of BMI, a critically important risk factor for diabetes (Mokdad et al., 2003). Weight loss is a critical cornerstone of successful diabetes prevention and management, and it is the most frequent target of prevention and intervention efforts (Knowler et al., 2002). Although the importance of targeting BMI to improve glucoregulation is undisputed, additionally targeting well-being may achieve even greater risk reductions. Intervention efforts have been successful at increasing well-being, including purpose in life but not peaceful disengagement, within a community sample of older adults (Friedman et al., 2015) as well as reducing recurrence of major depression and generalized anxiety disorder within clinical populations (Fava et al., 2004; Ruini & Fava, 2009). The extent to which these efforts may bolster physical health is an important avenue for future research. In addition, whether interventions developed in Western cultures can be effective in other cultural contexts needs to be empirically tested. Some studies have found that interventions that worked in the United States (e.g., expressive writing, gratitude) were not effective in Asian cultural contexts (Knowles, Wearing, & Campos, 2011; Layous, Lee, Choi, & Lyubomirsky, 2013). Alternatively, a "kindness" intervention, which fits Asian cultural norms, has been shown to work in Asian cultural contexts (Layous et al., 2013; Otake, Shimai, Tanaka-Matsumi, Otsui, & Fredrickson, 2006). The present study points to a possibility that interventions seeking to foster purpose in life may be effective across both cultural contexts.

Although the primary focus of this inquiry was on well-being predictors of glucoregulation in Japanese adults, associations between well-being and three other markers of cardiovascular risk were examined to facilitate comparisons with previously published research from MIDUS (Boehm et al., 2016; Boylan & Ryff, 2015; Zilioli et al., 2015). The additional outcomes included systolic blood pressure, total to HDL cholesterol ratio, and waist circumference. There was no evidence of associations between the well-being measures and total to HDL cholesterol ratio and waist circumference in MIDJA, in contrast to significant associations between purpose in life and life satisfaction with lipid profiles in the United States. However, Japanese adults endorsing that they have *ikigai* in their lives had approximately 4 mmHg lower systolic blood pressure than those reporting no *ikigai*. None of the culture by well-being interactions significantly associated with HbA1c, indicating that there were no cultural differences in the link between well-being and HbA1c. These additional analyses lend further support for the health relevance of purpose in life and its Japanese counterpart *ikigai* across cultures.

Several limitations must be acknowledged. First, associations are cross-sectional in nature, and thus it is impossible to discern the direction of causality among well-being and glucoregulation. Only a small proportion of the sample exhibited HbA1c levels within the diabetic range, which weakens the argument that the burden of diabetes could have caused lower well-being. Nonetheless, longitudinal data, which are forthcoming in this sample, will bolster the argument that a psychological profile marked with high well-being predicts physical health. The measure of physical activity was also a limitation, given the important role of this mediating factor in understanding links between positive psychological factors and HbA1c. Additionally, although the exclusive focus on positive psychological factors did not allow us to test whether negative psychological traits and emotions predicted poorer glucoregulation, we were able to compare multiple varieties of well-being, including those developed within Japan, and we view the inclusion of these culturally sensitive measures as a unique strength of the study. Future research needs to investigate associations between negative emotions and HbA1c across cultures, building on accumulating evidence of stronger links between negative affect and anger and markers of health in the United States as compared with Japan (Curhan et al., 2014; Kitayama et al., 2015; Miyamoto et al., 2013). Finally, given the focus on the independent associations among well-being and glucoregulation, key life course or socioeconomic differences were not considered in the present study. Evidence supports that that well-being may change across the life course in Japan (Karasawa et al., 2011), and also that well-being may predict health more strongly among those of lower socioeconomic status (Lachman, Agrigoroaei, Murphy, & Tun, 2010; Morozink, Friedman, Coe, & Ryff, 2010; Turiano, Chapman, Agrigoroaei, Infurna, & Lachman, 2014), which both constitute important directions for future research.

Notwithstanding these limitations, this study represents an important test of the generalizability of positive associations among psychological well-being and physical health. A key strength was the examination of multiple dimensions of well-being, including constructs that have shown to be protective in the United States and Western populations (e.g., hedonic and eudaimonic well-being) as well as constructs that were developed within an interdependent cultural context (i.e., *ikigai*, adjustment, minimalist well-being). Examining various types of well-being simultaneously is necessary to discern their relative associations with health, yet this is rarely done within the same study. A central message from this inquiry is that purpose in life predicts better glucoregulation profiles among Japanese adults, and further, that its Japanese counterpart, *ikigai*, is associated with lower systolic blood pressure.

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