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Loneliness and risk for cardiovascular disease in the United States and Japan: The effects of nationality, collectivism, and gender

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ABSTRACT

Rationale: Loneliness is a global concern associated with adverse effects on cardiovascular disease (CVD) that may differ by nationality, collectivism, and gender.
Objective: This study examined whether associations between loneliness and CVD indicators (e.g., metabolic dysregulation [MetD], inflammation, sleep dysfunction) would vary by nationality, collectivism, and gender. We predicted that loneliness would be associated with poorer CVD values in (1) Japan than the United States (U.S.), (2) in individuals higher rather than lower in collectivism, and (3) our exploratory hypotheses about gender were that loneliness would interact with gender to be associated with differential CVD indicators in the U.S. versus Japan.
Methods: Participants (aged 36 to 78) from the MIDUS Refresher Biomarker (n = 644) and the MIDJA 2 Biomarker studies (n = 293) completed questionnaires, bloodwork, and a physical exam. U.S. participants were from multiple cities, and Japanese participants were from Tokyo. Loneliness was measured via responses to the question, "How often in the past week did you feel lonely?" Logistic regression and path analyses using structural equation modeling determined individual differences in loneliness, whether loneliness predicted CVD indicators, and whether nationality, collectivism, and gender moderated these associations.
Results: Loneliness was prevalent in the U.S. (25.39%) and Japan (20.82%). Unexpectedly, Japanese adults reported less collectivism than U.S. adults. We found significant interactions of (1) nationality and gender on MetD and inflammation, (2) gender and loneliness on sleep dysfunction, and (3) nationality and loneliness on MetD. Loneliness was associated with greater MetD in the U.S. but not in Japan.
Conclusions: Cultural influences on loneliness contradicted expectations and suggested caution when equating nationality with cultural values. Our Japanese sample was from Tokyo, which may have lower collectivism than rural Japanese regions. We recommend future studies consider geographic location when examining associations between loneliness, collectivism, and CVD.

1. Introduction

Approximately 22% of Americans and nine percent of Japanese adults report loneliness (DiJulio et al., 2018). Loneliness is the painful feeling of social isolation when one perceives deficiencies in the number and/or quality of one's social relationships (Perlman and Peplau, 1998). We know loneliness is associated with an elevated risk for cardiovascular disease (CVD) and mortality within Western cultures (e.g., United States [U.S.]; Holt-Lunstad, 2017). There is less knowledge about loneliness and CVD in Asian samples and in relation to cultural values.

Perceptions of loneliness are culturally driven because cultures have different expectations about social relationships (Perlman and Peplau, 1998). The culture-loneliness framework (Heu et al., 2021) posits that more socially restrictive cultures (e.g., collectivistic) may protect against loneliness by promoting social integration. Collectivistic groups (e.g., Asian) place value on social cohesion and interdependence (Ozawa-de Silva, 2020). Western cultures are considered higher in individualism, which emphasizes independence and personal autonomy (Oyserman et al., 2002).

Studies about loneliness in collectivistic and individualistic groups yield a complex picture. On the one hand, individual levels of collectivism were associated with lower loneliness in samples from five

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European countries (Heu et al., 2019). Similarly, Japanese adults reported less loneliness than adults from two individualistic countries, the U.S. and United Kingdom (DiJulio et al., 2018). In contrast, a review paper that considered group levels of collectivism found that more individualistic cultures were protective against loneliness due to lower expectations regarding interpersonal relationships (Heu et al., 2021). Thus, when examining cultural factors contributing to loneliness, results may differ depending on whether nationality or individual levels of collectivism are utilized.

In addition to nationality and self-reported values, gender is an important factor in determining loneliness. There are conflicting theories regarding gender differences in loneliness (Maes et al., 2019). One theory posits that because women are higher in internalizing problems than men – and because loneliness can be considered an internalizing problem – loneliness may be higher in women (Creemers et al., 2012). However, another theory suggests that women have more dyadic, intimate attachments than men, and thus women are less vulnerable to loneliness than men (Hoza et al., 2000).

Indeed, gender differences in loneliness yield mixed results. A meta-analysis – that predominantly included studies from the U.S., Canada, and Europe – found that men were lonelier than women, but this effect was not found in studies with more than 100 participants (Maes et al., 2019). One cross-national study that included adults from 237 countries reported that men from individualistic countries were more likely to experience loneliness than women and people from collectivistic countries (Barreto et al., 2020). In Japanese adults aged 50–70, men reported greater loneliness than women (van den Broek, 2017).

It is important to determine if nationality, self-report values, and/or gender are important in determining loneliness because loneliness is associated with poor health (Holt-Lunstad, 2017). The Cognitive Model of Loneliness (Cacioppo and Hawkley, 2009) offers a framework for understanding the health risks associated with loneliness. The model proposes that when one perceives themselves as lonely – which is likely culturally determined (Perlman and Peplau, 1998) – they might be motivated to seek relationships and hypervigilant to social threats. Hypervigilance to social cues and negative affect can activate neurobiological responses, including overactivation of the hypothalamic-pituitary-adrenal (HPA) axis and diminished sleep quality. HPA axis dysregulation and sleep disruption are implicated in the pathogenesis of CVD (Cacioppo and Hawkley, 2009).

Lonely individuals in Western samples show abnormal levels of metabolic dysregulation (MetD) biomarkers, including elevated blood pressure (BP; Hawkley et al., 2010), greater waist circumference (WC), and higher metabolic syndrome risk (Whisman, 2010). Loneliness was associated with greater risk of coronary heart disease in U.S. women, but not U.S. men (Thurston and Kubzansky, 2009). Data on the associations between loneliness and MetD are limited in Japan and other samples considered high in collectivism. One study found that perceived emotional support – a construct related to loneliness – was associated with elevated metabolic syndrome in Japanese men (Ikeda et al., 2011). Persons who identify as Hispanic residing in the U.S. – who are relatively high in collectivism – experienced elevated MetD in response to loneliness relative to individualistic groups (Shiovitz-Ezra and Parag, 2019).

Lonely persons have increased inflammation in Western samples (Eisenberger et al., 2017) and East Asian samples (S.-H. Lee et al., 2021). Lonely middle-aged adults in the U.S. possess elevated levels of three systemic inflammation biomarkers – interleukin-6 (IL-6), fibrinogen, and C-reactive protein (CRP) – compared to their non-lonely counterparts (Nersesian et al., 2018). Loneliness was associated with higher inflammation in U.S. women compared to U.S. men (Hackett et al., 2012). However, in Japan, loneliness was associated with elevated inflammation in men but not women (Koyama, 2021).

Associations between loneliness and sleep are found in U.S. (Hom et al., 2020) and Asian (Jia and Yuan, 2020) samples. For example, in a rural Chinese older adult sample, loneliness was significantly associated with sleep dysfunction (Jia and Yuan, 2020). A meta-analysis that included studies from the U.S., Europe, and Asia found a significant, medium-sized association between sleep problems and loneliness, with U.S. samples yielding larger effect sizes than other groups (Hom et al., 2020).

Prior studies examining how collectivism moderates the associations between loneliness and health outcomes used different measures of collectivism. Beller and Wagner (2020) found that the associations between loneliness and health outcomes, including poorer grip strength and cognitive performance, were stronger in individuals from European nations higher in collectivism. In an adult sample from South Korea – a nation considered high in collectivism – loneliness was associated with elevated inflammatory response among adults with high, but not low, self-reported collectivism (S.-H. Lee et al., 2021).

1.1. The current study

Thus, there is limited knowledge about how nationality and individual-level collectivism moderate associations between loneliness and CVD indicators. Previous studies that examine how nationality moderates the associations between loneliness and adverse health outcomes did not include CVD indicators (Beller and Wagner, 2020). Further, no studies examine how individual-level collectivism moderates the associations between loneliness and CVD outcomes, other than inflammatory markers (S.-H. Lee et al., 2021).

Given the limited research examining how collectivism influences the associations between loneliness and CVD risk factors, we will determine how nationality and/or individual collectivism are associated with loneliness and the associations between loneliness and CVD indicators. We included nationality and a self-report measure of individual collectivism to determine which measure(s) were useful in understanding differences in loneliness and health and whether using nationality as a proxy for individual cultural values is appropriate.

U.S. participants were drawn from several U.S. cities, and the Japanese sample was drawn from Tokyo. We hypothesized that loneliness would be greater in individuals higher in individualism than collectivism (Heu et al., 2021), in the U.S. than Japan (DiJulio et al., 2018), and in men than women (Barreto et al., 2020). We also hypothesized that associations between loneliness and health outcomes will vary by nationality and individual collectivism.

We expected a stronger association between loneliness and CVD indicators for individuals higher in collectivism (S.-H. Lee et al., 2021) and Japanese adults relative to the U.S. (Beller and Wagner, 2020). Expectations regarding gender effects were exploratory. Based on previous research, we expected that lonely U.S. women might have worse CVD-related outcomes than lonely U.S. men (Hackett et al., 2012; Thurston and Kubzansky, 2009), and lonely Japanese men might have worse CVD risk outcomes than Japanese women (Koyama, 2021).

2. Methods

Data for the U.S. and Japanese samples were from the Midlife in the United States (MIDUS) Refresher: Biomarker Project (2012–2016; Weinstein et al., 2017) and the Midlife in Japan (MIDJA) 2: Biomarker Project (2013–2014; Ryff et al., 2019), respectively (http://midus.wisc.edu/). Study protocols were approved by the Institutional Review Board at the University of Wisconsin-Madison.

2.1. Participants

The U.S. sample included 644 participants (49.84% women) who self-identified as White (82.1%), Black (7.3%), Native American (2.2%), Asian (1.2%), Native Hawaiian or Pacific Islander (0.2%), and 'other' race (7.0%; Table 1). The Japanese sample included 293 (53.92% women) participants. All participants were aged 36–78 years.

Table 1
Descriptive statistics for men and women from the United States and Japan.

Variables	United States			Japan			Nationality		Gender		Nationality × Gender	
	Men (n = 323)	Women (n = 321)	Total (N = 644)	Men (n = 135)	Women (n = 158)	Total (N = 293)	Est.	p	Est.	p	Est.	p
Lonely[a]	22.29%	27.73%	25.00%	19.26%	22.15%	20.82%	1.95	.163	22.21	<.001	–	-
Collectivism	5.15 (0.61)	5.15 (0.66)	5.15 (0.64)	4.76 (0.63)	4.82 (0.61)	4.79 (0.62)	66.73	<.001	0.74	.390	0.39	.535
Sociodemographic												
Age (years)	58.32 (11.65)	55.37 (10.99)	56.85 (11.41)	59.67 (12.00)	58.04 (12.40)	58.80 (12.22)	1.58	.209	7.57	.006	0.53	.467
Married[b]	74.61%	57.63%	66.15%	75.56%	65.82%	70.31%	1.77	.183	22.21	<.001	–	-
Education							193.00	<.001	32.93	<.001	–	-
8th Grade	0.31%	0.31%	0.31%	2.96%	6.33%	4.78%						
Some High School	1.86%	1.87%	1.86%	2.22%	0.63%	1.37%						
High School	12.07%	12.46%	12.27%	26.67%	37.34%	32.42%						
2-Year College	8.98%	10.90%	9.94%	5.19%	32.91%	20.14%						
Some College	17.96%	17.13%	17.55%	3.70%	0.63%	2.05%						
Bachelor's Degree	25.39%	27.41%	26.40%	52.59%	19.62%	34.81%						
Graduate School	33.44%	29.60%	31.52%	6.67%	1.90%	4.10%						
Income (USD per month)							92.34	<.001	21.65	<.001	–	–
<800	4.33%	8.10%	6.21%	<.01%	1.27%	0.68%						
800–2100	6.19%	6.23%	6.21%	9.63%	13.29%	11.60%						
2100–4200	10.84%	16.51%	13.66%	29.63%	36.08%	33.11%						
4200–8300	33.75%	34.89%	34.32%	36.30%	33.54%	34.81%						
>8300	41.49%	30.22%	35.87%	20.74%	8.86%	14.33%						
Psychosocial												
Depressive Symptoms	26.31 (6.52)	27.69 (6.84)	27.00 (6.71)	27.23 (5.91)	28.96 (6.12)	28.14 (6.07)	6.59	.010	9.37	.002	0.19	.661
STAI-T	33.40 (9.01)	35.46 (8.79)	34.43 (8.95)	38.57 (9.10)	39.06 (8.22)	38.84 (8.62)	40.80	<.001	3.70	.055	1.46	.227
Medications												
Are you currently taking medications for												
Diabetes[c]	0.00%	0.62%	0.31%	6.67%	2.53%	4.44%	21.77	<.001	0.75	.385	–	–
Cholesterol[c]	2.48%	2.49%	2.48%	10.37%	11.39%	10.92%	29.49	<.001	.019	.665	–	–
Hypertension[c]	0.62%	0.31%	0.47%	18.52%	15.82%	17.06%	103.98	<.001	0.10	.757	–	–
Heart Disease[c]	0.00%	0.00%	0.00%	4.44%	0.63%	2.39%	15.50	<.001	3.83	.050	–	–
Medical Conditions												
Have you ever had a												
Stroke[c]	3.41%	4.05%	3.73%	2.22%	0.63%	1.37%	3.73	.053	0.02	.894	–	–
Cancer[c]	17.65%	17.45%	17.55%	11.11%	0.08%	9.22%	11.28	<.001	0.47	.493	–	–
Heart Disease[c]	12.07%	9.35%	10.71%	7.41%	1.90%	4.44%	9.09	.003	4.36	.037	–	–
Cholesterol Problems[c]	47.37%	35.51%	41.46%	26.67%	30.38%	28.67%	16.29	<.001	6.95	.008	–	–
CVD Indicators												
Waist Circumference (cm)	104.78 (16.44)	92.66 (19.77)	98.73 (19.15)	83.99 (9.29)	72.16 (7.62)	77.61 (10.28)	303.81	<.001	105.10	<.001	0.01	.935
HDL (mg/dL)	53.19 (17.38)	66.55 (20.88)	59.85 (20.32)	58.98 (17.36)	73.58 (15.99)	66.91 (18.13)	26.51	<.001	109.13	<.001	0.29	.589
Body Mass Index (kg/m^2)	30.14 (6.20)	29.69 (7.87)	29.92 (7.08)	23.83 (3.03)	22.02 (2.99)	22.85 (3.14)	235.13	<.001	6.05	.014	3.34	.068
Blood Pressure	106.17 (11.28)	99.70 (12.82)	102.94 (12.49)	106.71 (10.40)	100.47 (11.69)	103.34 (11.52)	0.66	.418	57.39	<.001	0.01	.913
Subjective Sleep Quality	0.90 (0.64)	0.97 (0.65)	0.94 (0.64)	1.14 (0.73)	1.08 (0.67)	1.11 (0.70)	10.77	<.001	0.28	.599	0.98	.323
Sleep Latency	0.78 (0.80)	0.93 (0.90)	0.85 (0.85)	0.80 (0.93)	0.86 (0.90)	0.83 (0.92)	1.42	.234	0.91	.341	1.58	.210
Sleep Duration	0.73 (0.74)	0.75 (0.76)	0.74 (0.75)	1.08 (0.80)	1.07 (0.75)	1.07 (0.77)	35.13	<.001	0.17	.681	<0.01	.962
Sleep Disturbance	1.18 (0.54)	1.32 (0.56)	1.25 (0.55)	1.06 (0.46)	1.08 (0.39)	1.07 (0.42)	23.95	<.001	3.23	.073	2.78	.096
Daytime Disturbance	0.77 (0.74)	0.88 (0.68)	0.82 (0.71)	0.83 (0.64)	0.74 (0.63)	0.78 (0.64)	0.48	.489	0.014	.904	3.04	.082
Fibrinogen (mg/dL)	336.22 (71.08)	352.54 (71.86)	344.33 (71.88)	300.63 (63.66)	308.11 (54.86)	304.70 (59.04)	72.03	<.001	7.96	.005	0.37	.542
C-Reactive Protein[d] (ug/mL)	0.06 (0.46)	0.19 (0.54)	0.12 (0.50)	−0.26 (0.55)	−0.53 (0.45)	−0.41 (0.51)	215.83	<.001	3.139	.077	28.71	<.001
Interleukin-6[d] (mg/dL)	0.34 (0.33)	0.30 (0.35)	0.32 (0.34)	0.06 (0.32)	−0.02 (0.34)	0.01 (0.33)	170.50	<.001	4.392	.036	0.33	.569

Note. All p values are two-tailed. Continuous variables are reported as: M (SD). STAI-T = Spielberger Trait Anxiety Inventory. HDL-C = High-Density Lipoprotein Cholesterol. Est. = Estimate. Reference group was [a]not lonely, [b]not married, [c]no, [d]log-transformed.

2.2. Procedure

2.2.1. Recruitment

MIDUS Sample. The U.S. sample was drawn from probability sampling using telephone sampling frames. Eligible respondents were English-speaking adults living in residential units in the USA between the ages of 25 through 74. No exclusion criteria were specified. Participants were completed a telephone interview (59% response rate) to

collect data on health, sociodemographic, and contact information. Next, participants were sent a self-administered questionnaire (SAQ; 73% response rate). If participants mailed back the SAQ, they were invited to participate in a biomarker visit (41.49% response rate). We removed participants below age 36 from the MIDUS sample to ensure similar age ranges in the U.S. and Japanese samples.

MIDJA 2 Sample. The Japanese sample was drawn from an age-stratified random sample scheme based on the official registry of the Tokyo municipal office. Eligible respondents were individuals between ages 30 and 79 living in one of the 23 wards within Tokyo. No exclusion criteria were specified. The research team called participants to obtain informed consent. First, participants completed a baseline SAQ (56.21% response rate), which was delivered to the participants' house and picked up one week later from the participants' residence. Individuals who completed the baseline SAQ were invited to participate in a follow-up SAQ (73.70% response rate). Those who completed the follow-up SAQ were invited to participate in the MIDJA 2 biomarker study (50.85% response rate). The minimum age for MIDJA 2 biomarker participants was 36.

2.2.2. Biomarker visit

Participants completed questionnaires about their physical health, blood draws, and a physical exam. Blood samples were shipped to MIDUS-affiliated laboratories for analysis. Except for demographic data (i.e., race, income, education), which were collected from SAQs, all data were collected at the Biomarker Visit.

2.3. Measures

2.3.1. Loneliness

Loneliness was measured by the Center for Epidemiological Studies Depression Inventory (CES-D; Radloff, 1977), which asks participants to report how often in the past week they felt lonely (1 = rarely or none of the time; 4 = most or all of the time). Most responses in both samples were "rarely or none of the time" (75.0% for U.S.; 79.2% for Japan), and the other responses were dispersed across the other response options, causing right skewness ($\gamma = -8.45$, $SE = 0.07$). Thus, we decided to classify responses of "rarely or none of the time" as 'not lonely' and responses in any of the other three categories as 'lonely,' consistent with previous studies (Shiovitz-Ezra and Parag, 2019).

Single-item measures of loneliness are trustworthy and reliable (Mund et al., 2023). The CES-D single loneliness item had 81% sensitivity and specificity relative to the three-item UCLA Loneliness Scale in a receiver operation curve analysis (Shiovitz-Ezra and Ayalon, 2012). Direct single-item measures of loneliness frequency (e.g., "How often do you feel lonely?") were highly correlated ($rs \geq 0.80$) with multi-item scales and were adequately reliable ($r_{xx} = 0.77$) within a German adult sample (Mund et al., 2023).

2.3.2. Collectivism

Collectivism was measured with the interdependent subscale of Singelis' Self-Construal Scale (SCS; Singelis, 1994). The ten-item subscale asks participants how much they agree with statements related to collectivism (i.e., "I feel good when I cooperate with others."). Items were summed to create a total collectivism score. The SCS had questionable reliability in the U.S. ($\alpha = 0.69$; $M = 5.15$, $SD = 0.64$) and acceptable reliability in the Japanese sample ($\alpha = 0.70$; $M = 4.79$, $SD = 0.62$).

2.3.3. Metabolic dysregulation

Metabolic biomarkers included HDL, BP, body mass index (BMI), and WC. Lower values of HDL, and higher values of BP, BMI, and WC reflect greater MetD (Day, 2007). U.S. participants' HDL levels were analyzed at Meriter Labs (Madison, WI) using a Roche Cobas analyzer (Roche Diagnostic, Indianapolis, IN). Japanese participants' HDL data were analyzed at Showa Medical Science in Japan.

BP, BMI, and WC were collected during the physical exam. BMI was calculated by dividing participants' weight (kg) by their squared height (m^2). To measure WC (cm), study personnel measured the narrowest point between the participants' ribs and the iliac crest. Systolic BP (SBP) and diastolic BP (DBP) were measured three times consecutively, allowing a maximum of 30 s between each measurement, and then averaged.

2.3.4. Inflammation

We examined three key biomarkers of systemic inflammation: IL-6, fibrinogen, and CRP (Kannel, 1987; McManus et al., 2013). High values of inflammation biomarkers indicate a pro-inflammatory state (Coe et al., 2011). Fibrinogen and CRP were assayed at the Laboratory for Clinical Biochemistry Research at the University of Vermont using the BNII nephelometer (N Antiserum to Human Fibrinogen; Siemens, Malvern, PA). IL-6 was measured using the Quantikine High-sensitivity ELISA kit #HS600B (R&D Systems, Minneapolis, MN). No participants had CRP levels indicating acute inflammation (i.e., CRP levels >100.0 μg/mL) induced by infection or injury (Y. C. Yang et al., 2014; Y. Yang and Kozloski, 2011).

2.3.5. Sleep dysfunction

Participants completed the Pittsburgh Sleep Quality Index (PSQI), a 19-item self-report measure of sleep in the past month (Buysse et al., 1989). There are seven subscales on the PSQI, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medications, and daytime dysfunction. Each sleep subscale score ranged from 0 to 3, with higher scores indicating greater sleep dysfunction. Using a confirmatory factor analysis (CFA), we created a latent factor of sleep dysfunction from the PSQI subscales.

2.3.6. Covariates

Covariates were selected based on significant associations with loneliness and/or CVD indicators.

Demographics. We controlled for age, marital status (0 = not married, 1 = married), education, and income (Cohen-Mansfield et al., 2016). Participants reported their highest level of education from 1 (8th grade or less) to 8 (graduate school). Participants monthly total household income (1 U.S. dollar [USD] = 10 Japanese Yen) was coded from 1 (<800 USD) to 5 (>8300 USD).

Psychosocial. Depressive symptoms were measured by summing all CES-D items except for the loneliness item (Radloff, 1977). Internal consistency was good for the U.S. sample ($\alpha = 0.86$) and acceptable for the Japanese sample ($\alpha = 0.77$).

Trait anxiety was measured via the Spielberger Trait Anxiety Inventory (STAI-T) (Spielberger, 1989). Participants rated how they generally feel regarding anxiety-related statements (e.g., "I am inclined to take things hard.") from 1 (Almost Never) to 4 (Almost Always). Items were summed to create a STAI-T total score. The STAI-T had excellent internal consistency in the U.S. sample ($\alpha = 0.91$) and good internal consistency in the Japanese sample ($\alpha = 0.89$).

Medical Conditions and Medications. For analyses predicting CVD indicators, we controlled for whether the participant has had a stroke, cancer, heart disease, and/or high cholesterol in their lifetime (yes/no) and whether the participant (yes/no) reported currently taking medications for diabetes, high cholesterol, hypertension, or heart disease (Shiovitz-Ezra and Parag, 2019).

2.4. Data analyses

2.4.1. Preliminary analyses

Preliminary analyses were conducted using SPSS Version 26 (IBM Corp, 2019). Data were evaluated for normality and outliers (see Supplementary Results for skewness and kurtosis values). IL-6 and CRP values were log-transformed to reduce skewness. We performed a 2 (nationality: Japan, U.S.) × 2 (gender: men, women) multivariate

analysis of variance (MANOVA) and chi-square tests to determine differences based on nationality and gender on observed and categorical variables, respectively.

2.4.2. Inferential analyses

Inferential data analyses were conducted using MPlus version 8.1 (Muthén and Muthén, 2017). Full information maximum likelihood estimation was applied to missing values (T. Lee and Shi, 2021). To avoid model convergence issues, we rescaled several variables to ensure that variances across all variables were in similar metrics.

Logistic Regression. We performed a logistic regression to determine whether collectivism, nationality, and gender predicted loneliness prevalence. The logistic regression controlled for demographic and psychosocial covariates.

Confirmatory Factor Analysis. To extract latent constructs for CVD indicators (e.g., MetD, inflammation, sleep dysfunction) and test overall model fit, we conducted a CFA. Overall model fit was determined using the recommendations of (Kline, 2016): (a) the Comparative Fit Index (CFI), with values greater than .90 indicating good model fit; (b) the root mean square error of approximation (RMSEA), an absolute index of overall model fit with values less than .08 indicative of acceptable model fit and values less than .05 indicative of good model fit; and (c) the Standardized Root Mean Residual (SRMR) an absolute index of overall model fit with values less than .10 indicative of good model fit.

Path Analysis. To determine how loneliness, and the interactions of loneliness and nationality, collectivism, and gender, predicted CVD indicators, we tested separate path analyses using structural equation modeling (SEM). We used SEM because it allowed us to include multiple outcome variables in one model and to extract underlying latent factors from our outcome variables (Kline, 2016).

First, we tested the effect of loneliness on CVD indicators, controlling for nationality, collectivism, and gender (Fig. 2A). Second, we tested a model predicting CVD indicators that included the main effects and interactions between (1) nationality and loneliness, (2) collectivism and loneliness, (3) gender and loneliness, and (4) gender and nationality (Fig. 2B). We included the two-way interaction of nationality and gender to include all the two-way interactions that underlie the three-way interaction of nationality, gender, and loneliness, which we test in the third model (e.g., nationality × loneliness, gender × loneliness, nationality × gender). If we found significant interaction effects, we performed simple effects tests to probe the effects of each predictor on the outcome level of the other predictor (Hayes, 2018). Our two-way interaction model is conceptually similar to PROCESS Model 2, as it includes multiple two-way interactions but no higher-order three-way interaction (Hayes, 2018). Third, we performed a model that included the three-way interaction between loneliness, gender, and nationality to test our hypothesis that the association between loneliness and CVD indicators might differ between gender and nationality (Fig. 2C). To compare these models, we examined the significance of the interaction terms on each outcome and model comparison tests between these models to determine if the addition of interaction terms significantly increased model fit.

3. Results

3.1. Preliminary analyses

Unexpectedly, loneliness did not differ significantly between the U.S. (25.0%) and Japanese (20.8%) samples (Table 1). U.S. adults reported significantly more collectivism, fewer depressive symptoms, and less anxiety than Japanese adults (*ps* $\leq$ .010). U.S. adults had significantly worse values for metabolic and inflammation biomarkers (e.g., higher values for all inflammation biomarkers, WC, BMI, and lower HDL) than Japanese adults (*ps* $\leq$ .001). Although U.S. adults reported significantly worse subjective sleep quality, Japanese adults reported less sleep duration and greater daytime disturbance (*ps* $<$ .001). Japanese versus U.S. participants reported more medications (*ps* $<$ .001).

Gender differences on CVD indicators were mixed, with women having significantly better values on most metrics (i.e., lower IL-6, WST, BMI, BP, and high HDL) but poorer fibrinogen values than men (*ps* $\leq$ .05). Women reported significantly more depressive symptoms than men ($p = .002$).

We found a significant interaction between nationality and gender on CRP values (F (1, 936) = 28.71, $p = .002$). Pairwise comparisons indicated that U.S. women had higher CRP than U.S. men (t (2,636) = −3.24, $p = .001$) and Japanese women (t (2,473) = 14.34, $p < .001$). Additionally, Japanese men had higher CRP than Japanese women (t (2,289) = 4.54, $p < .001$) and lower CRP than U.S. men (t (2,452) = 6.41, $p < .001$).

3.2. Logistic regression predicting loneliness from nationality and collectivism

Contrary to expectations, a logistic regression predicting loneliness indicated that neither nationality, collectivism, nor gender were significantly associated with loneliness (Table 2; *ps* $>$ .05). Findings were similar for a series of logistic regressions predicting loneliness from nationality, gender, and collectivism separately.

3.3. Confirmatory factor analysis of CVD indicators

We hypothesized that a three-factor model (i.e., MetD, inflammation, and sleep dysfunction) would best fit the CVD indicator data. The MetD latent factor was indicated by WC, BMI, HDL, SBP, and DBP. The inflammation latent factor was indicated by IL-6, fibrinogen, and CRP. The sleep dysfunction latent factor was indicated by seven subscales from the PSQI. However, the three-factor CVD Indicators model did not fit the data (χ^2 [102, $N = 821$] = 817.15, $p < .001$, CFI = 0.80, RMSEA = 0.09, SRMR = 0.08; see Supplementary Results for the three-factor CFA model parameters).

Due to poor fit for the three-factor model, we made several changes to the CFA. First, BP was created as a separate factor from MetD. While BP may be conceptualized theoretically as an indicator of MetD for empirical reasons like our own, previous studies have analyzed these variables separately (Kobos et al., 2020; Shankar et al., 2011). The two-item BP latent factor was indicated by the average of SBP and DBP, using a calculated measurement error based on the reliability and variance of these two indicators (see Supplementary Results for more

Table 2
Model parameters for logistic regression predicting loneliness from collectivism and nationality.

	Estimate			Odds Ratio			Odds Ratio (95% CI)
	B	*SE*	*p*	*b*	*SE*	*p*	
Japan[a]	−0.43	0.22	.053	0.65	0.14	.016	[-0.86, 0.01]
Collectivism	0.09	0.15	.569	1.09	0.17	.585	[-0.46, 0.29]
Women[b]	−0.09	0.19	.653	0.92	0.18	.639	[-0.12, 0.05]
Age	−0.01	0.01	.526	1.00	0.01	.525	[-0.02, 0.01]
Married[c]	−0.10	0.22	<.001	0.37	0.08	<.001	[-0.02, −0.57]
Education	0.12	0.07	.086	1.12	0.08	.105	[-0.02, 0.25]
Income	0.11	0.10	.301	1.11	0.11	.327	[-0.09, 0.30]
Anxiety	0.06	0.02	<.001	1.06	0.02	<.001	[0.03, 0.09]
Depressive Symptoms	0.14	0.02	<.001	1.15	0.02	<.001	[0.10, 0.18]

Note. Reference group was [a]United States, [b]men, [c]not married.

details). Second, two items were removed from the sleep dysfunction latent factor. We removed the habitual sleep efficiency and use of sleeping medications subscales because their standardized factor loadings on the sleep dysfunction latent factor were less than .30. Other than the BP variable, all variances were set to 0 to obtain one latent mean in the analysis.

The four-factor CVD indicators model (Fig. 1) had a significant χ^2 fit statistic ($p < .001$) – as would be expected given the large sample size – and the model had a good fit on all other indices (Table 3). The four-factor model (i.e., MetD, BP, inflammation, and sleep dysfunction) was a significantly better fit to the data than the three-factor model ($\Delta\chi^2$ (42) = 665.94, $p < .001$). The standardized factor loadings for all latent variables were generally large and statistically significant ($ps < .001$). The MetD, BP, and inflammation latent variables were significantly correlated ($ps < .001$).

3.4. Predicting CVD indicators from loneliness, nationality, gender, and collectivism

For the following path analyses, loneliness, nationality, and gender were added as binary predictors, with non-lonely individuals, U.S. adults, and men as reference groups. Collectivism was mean-centered. Each path analysis included demographic, psychosocial, medical condition, and medication variables as covariates. Given that we explored four different outcomes (e.g., MetD, inflammation, BP, sleep dysfunction), we applied a Bonferroni correction to an alpha level of .05; thus,

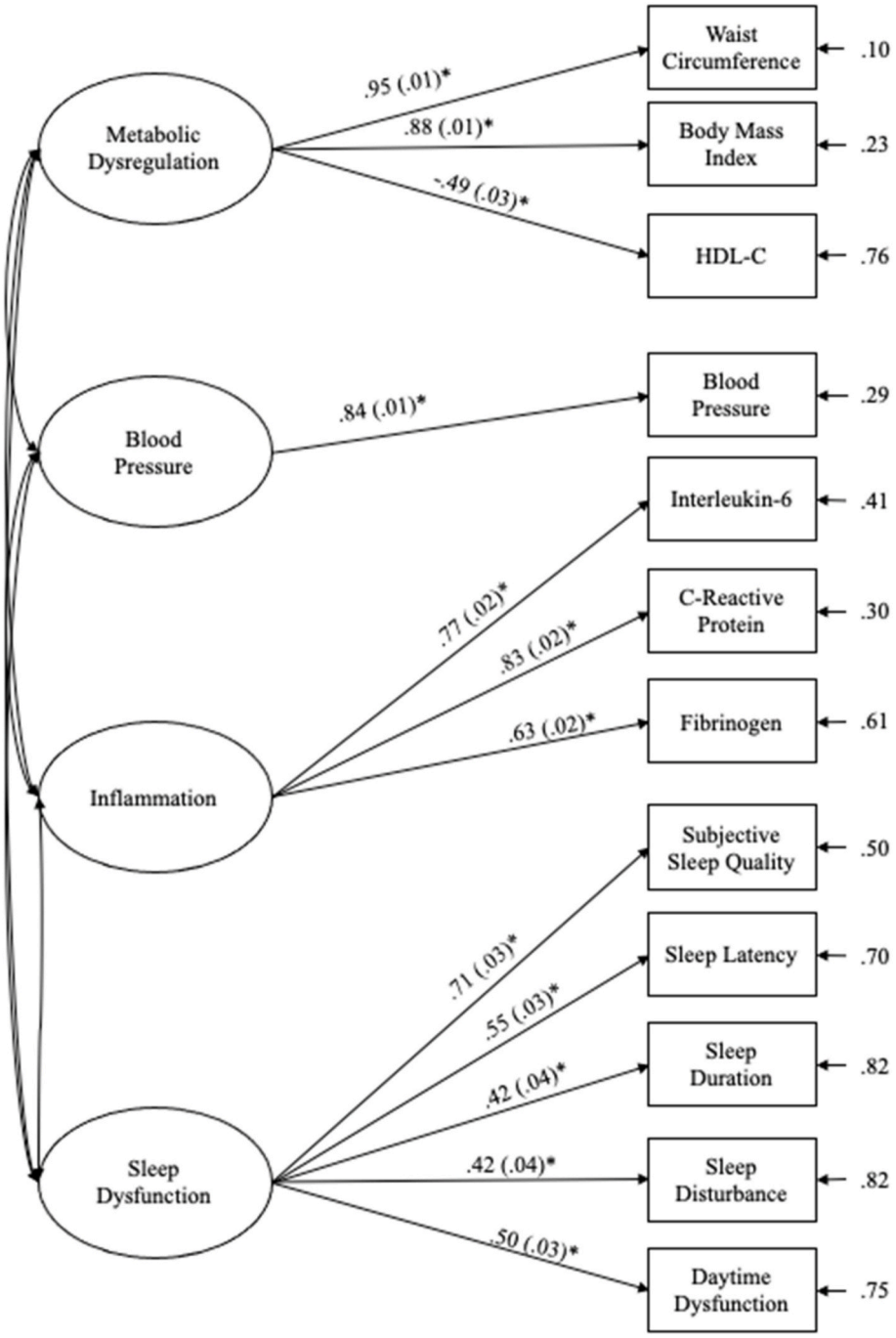

Fig. 1. CVD indicators path diagram with standardized Coefficients
Note. *$p < .001$.

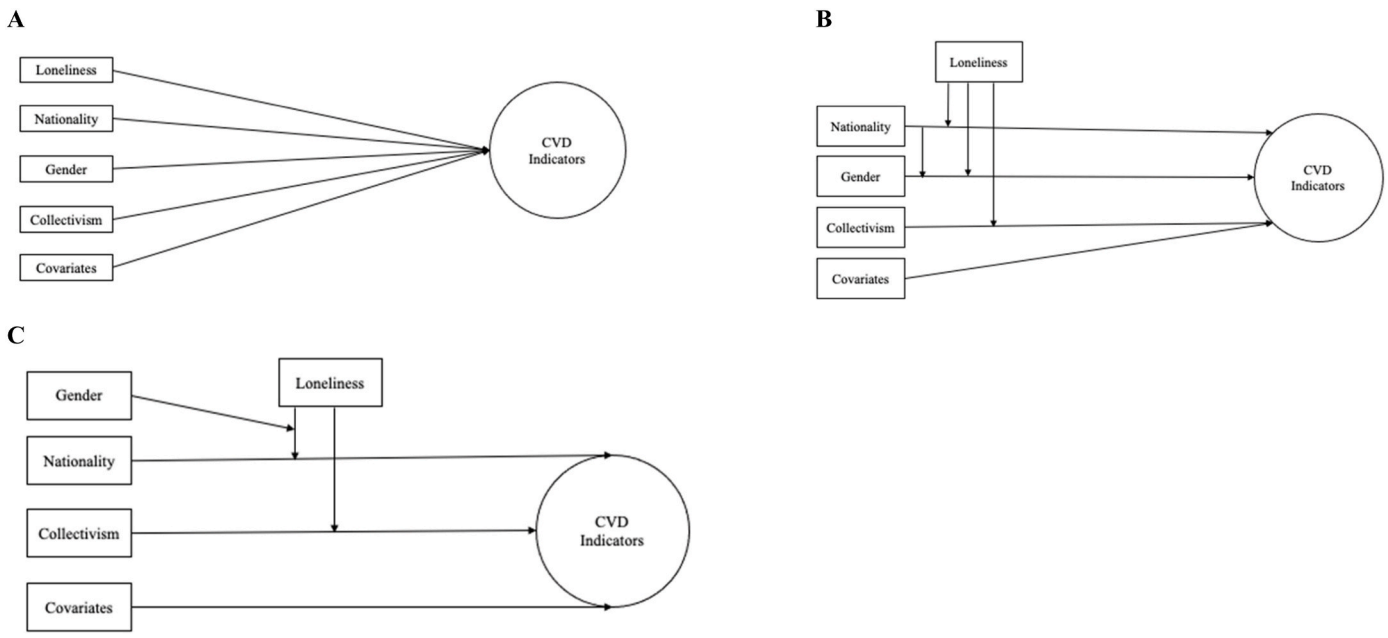

Fig. 2. Model diagrams of path Analyses
Note. (A) Main effects model regressing CVD indicators on loneliness, nationality, gender, and collectivism (B) two-way interactions model with loneliness × nationality, loneliness × gender, loneliness × collectivism, and nationality × gender (C) model including the three-way interaction of loneliness × nationality × gender on CVD indicators.

Table 3
Model parameters of four-factor CVD indicators model.

Standardized Factor Loadings			
	β	*SE*	*p*
Metabolic Dysregulation			
Waist Circumference	.95	.01	<.001
Body Mass Index	.88	.01	<.001
High Density Lipoprotein Cholesterol	−.49	.03	<.001
Blood Pressure			
Average Blood Pressure	.84	.01	<.001
Inflammation			
Interleukin-6	.77	.02	<.001
C-Reactive Protein	.83	.02	<.001
Fibrinogen	.63	.02	<.001
Sleep Dysfunction			
Subjective Sleep Quality	.71	.03	<.001
Sleep Latency	.55	.03	<.001
Sleep Duration	.42	.04	<.001
Sleep Disturbance	.42	.04	<.001
Daytime Dysfunction	.50	.03	<.001
Interfactor Correlations			
Metabolic Dysregulation			
Blood Pressure	.28	.04	<.001
Inflammation	.67	.03	<.001
Sleep Dysfunction	.05	.04	.196
Blood Pressure			
Inflammation	.25	.04	<.001
Sleep Dysfunction	−.08	.05	.074
Inflammation			
Sleep Dysfunction	.09	.05	.060
Goodness of Fit			
	Estimate	df	*p*
χ2 Test of Model Fit	231.01	60	<.001
Comparative Fit Index	0.95		
Root Mean Square Error of Approximation	0.06		
Standardized Root Mean Square Residual	0.05		

our corrected alpha level was .0125.

3.4.1. Loneliness, gender, nationality, and collectivism on CVD indicators

As expected, loneliness was significantly associated with elevated MetD, controlling for nationality and gender ($p = .001$; Table 4). Japanese adults had significantly lower MetD, inflammation, and sleep dysfunction than U.S. adults ($ps < .0125$). Women had significantly lower BP and MetD, and higher inflammation than men ($ps < .001$). Collectivism was not significantly associated with CVD indicators ($ps > .0125$).

3.4.2. Two-way interactions of loneliness and gender, nationality, and collectivism on CVD indicators

Metabolic Dysregulation. We found a significant interaction between nationality and loneliness on MetD ($p < .001$). Unexpectedly, the effect of loneliness on MetD was lower in Japan than in the U.S. ($b = -0.10$, $SE = 0.03$, $p < .001$). After examining the simple effects of this interaction, we found that at average collectivism, loneliness was associated with elevated MetD for U.S. men ($b = 0.32$, $SE = 0.11$, $p = .003$) and U.S. women ($b = 0.31$, $SE = 0.11$, $p = .004$), but not for Japanese men ($b = 0.22$, $SE = 0.10$, $p = .031$) or Japanese women ($b = 0.20$, $SE = 0.10$, $p = .044$).

We found a significant interaction between gender and nationality, such that the effect of nationality on MetD was higher in men than women ($b = -0.08$, $SE = 0.02$, $p < .001$). The simple effects of this interaction indicated that Japanese women had less MetD than U.S. women ($b = -0.20$, $SE = 0.02$, $p < .001$). Similarly, Japanese men had less MetD than U.S. men ($b = -0.12$, $SE = 0.02$, $p < .001$). U.S. women had less MetD than U.S. men ($b = -0.04$, $SE = 0.01$, $p < .001$). In Japan, the effect of gender was greater than in the U.S., and women had less MetD than men ($b = -0.12$, $SE = 0.02$, $p < .001$).

Blood Pressure. There was not a significant association between loneliness and BP or any significant interactions between loneliness and gender, nationality, or collectivism.

Inflammation. The interaction between gender and nationality was significant, such that the effect of nationality on inflammation was higher in men than women ($b = -0.49$, $SE = 0.09$, $p < .001$). The simple

Table 4
Model parameters for path analyses predicting CVD indicators from loneliness, nationality, gender, and collectivism.

	Effects							
	Metabolic Dysregulation		Blood Pressure		Inflammation		Sleep Dysfunction	
	b (*SE*)	*p*	*b* (*SE*)	*p*	*b* (*SE*)	*p*	*b* (*SE*)	*p*
Loneliness[a]	0.04 (0.01)	<.001	−0.01 (0.01)	.508	0.10 (0.06)	.069	−0.03 (0.04)	.452
Japan[b]	−0.17 (0.01)	<.001	0.001 (0.01)	.992	−0.77 (0.05)	<.001	−0.09 (0.03)	.010
Women[c]	−0.06 (0.01)	<.001	−0.05 (0.01)	<.001	0.12 (0.04)	.002	0.002 (0.03)	.922
Collectivism	−0.01 (0.01)	.418	0.001 (0.01)	.932	−0.01 (0.04)	.836	−0.002 (0.02)	.914
Age	−0.03 (0.05)	.506	0.18 (0.04)	<.001	1.36 (0.22)	<.001	−0.28 (0.14)	.041
Married[d]	−0.002 (0.01)	.867	−0.01 (0.01)	.572	−0.03 (0.05)	.565	−0.03 (0.03)	.406
Education	−0.01 (0.004)	.001	−0.004 (0.003)	.140	−0.06 (0.02)	<.001	−0.02 (0.01)	.094
Income	−0.002 (0.01)	.783	−0.002 (0.004)	.658	−0.05 (0.02)	.035	−0.01 (0.02)	.606
Depression	0.001 (0.001)	.450	0.001 (0.001)	.206	−0.001 (0.01)	.878	0.02 (0.003)	<.001
Anxiety	−0.02 (0.08)	.820	−0.04 (0.06)	.482	0.52 (0.34)	.125	1.86 (0.24)	<.001
Are you currently taking medications for								
Diabetes[e]	0.04 (0.04)	.390	0.06 (0.01)	.085	0.16 (0.18)	.375	0.001 (0.12)	.992
Cholesterol[e]	−0.05 (0.03)	.066	0.003 (0.02)	.876	−0.04 (0.10)	.715	0.04 (0.07)	.568
Hypertension[e]	0.004 (0.03)	.880	0.03 (0.02)	.122	0.06 (0.10)	.963	0.05 (0.07)	.453
Heart Disease[e]	0.03 (0.06)	.690	−0.04 (0.05)	.360	0.42 (0.25)	.099	0.39 (0.17)	.022
Have you ever had a								
stroke[e]?	0.05 (0.03)	.141	0.02 (0.02)	.411	0.19 (0.13)	.136	0.22 (0.09)	.008
cancer[e]?	0.04 (0.02)	.014	0.02 (0.01)	.161	0.10 (0.06)	.095	−0.001 (0.04)	.990
heart disease[e]?	0.04 (0.02)	.044	−0.02 (0.01)	.175	0.19 (0.08)	.014	0.07 (0.05)	.157
cholesterol problems[e]?	0.10 (0.01)	<.001	0.01 (0.01)	.101	0.14 (0.04)	.001	0.05 (0.03)	.093
	Two-Way Interactions							
Loneliness[a]	0.32 (0.11)	.003	−0.08 (0.08)	.309	0.68 (0.43)	.111	−0.27 (0.29)	.345
Japan[b]	−0.12 (0.02)	<.001	0.01 (0.01)	.650	−0.54 (0.07)	<.001	−0.07 (0.04)	.131
Women[c]	−0.04 (0.01)	<.001	−0.05 (0.01)	<.001	0.24 (0.05)	<.001	0.06 (0.03)	.063
Collectivism	0.001 (0.01)	.877	−0.003 (0.01)	.673	0.01 (0.04)	.801	−0.02 (0.03)	.518
Lonely × Japan	−0.10 (0.03)	<.001	−0.003 (0.02)	.873	−0.15 (0.11)	.174	0.05 (0.08)	.512
Lonely × Women	−0.01 (0.02)	.563	−0.02 (0.02)	.319	−0.08 (0.09)	.366	−0.20 (0.06)	.002
Lonely × Collectivism	−0.05 (0.02)	.016	0.02 (0.02)	.275	−0.11 (0.08)	.196	0.06 (0.06)	.252
Japan × Women	−0.08 (0.02)	<.001	−0.01 (0.02)	.386	−0.49 (0.09)	<.001	−0.10 (0.06)	.086
Age	−0.02 (0.05)	.651	0.18 (0.04)	<.001	1.38 (0.22)	<.001	−0.25 (0.14)	.066
Married[d]	−0.01 (0.01)	.651	−0.01 (0.01)	.478	−0.04 (0.05)	.444	−0.04 (0.03)	.289
Income	−0.001 (0.01)	.888	−0.002 (0.004)	.714	−0.05 (0.02)	.049	−0.01 (0.02)	.632
Education	−0.01 (0.004)	<.001	−0.004 (0.003)	.104	−0.07 (0.02)	<.001	−0.02 (0.01)	.039
Depression	0.001 (0.001)	.260	0.001 (0.001)	.172	0.002 (0.01)	.711	0.02 (0.003)	<.001
Anxiety	−0.02 (0.03)	.819	−0.04 (0.06)	.460	0.47 (0.33)	.150	1.86 (0.23)	<.001
Are you currently taking medications for								
Diabetes[e]	0.04 (0.04)	.412	0.06 (0.03)	.046	0.10 (0.17)	.547	−0.02 (0.12)	.878
Cholesterol[e]	−0.02 (0.03)	.394	0.005 (0.02)	.777	0.05 (0.10)	.645	0.04 (0.07)	.597
Hypertension[e]	0.02 (0.02)	.365	0.03 (0.02)	.079	0.11 (0.10)	.250	0.05 (0.07)	.440
Heart Disease[e]	0.02 (0.06)	.744	−0.04 (0.05)	.333	0.31 (0.25)	.216	0.34 (0.17)	.047
Have you ever had a								
Stroke[e]?	0.04 (0.03)	.219	0.02 (0.02)	.476	0.16 (0.13)	.167	0.21 (0.08)	.012
cancer[e]?	0.03 (0.02)	.034	0.02 (0.01)	.180	0.06 (0.06)	.285	−0.02 (0.04)	.703
heart disease[e]?	0.04 (0.02)	.063	−0.02 (0.01)	.152	0.15 (0.08)	.047	0.06 (0.05)	.253
cholesterol problems[e]?	0.10 (0.01)	<.001	0.01 (0.01)	.111	0.10 (0.04)	.017	0.04 (0.03)	.192

Note. Reference group was [a]not lonely, [b]United States, [c]men, [d]not married, [e]no.

effects of this interaction indicated a significant effect of nationality, such that Japanese women had lower inflammation than U.S. women ($b = -1.03$, $SE = 0.08$, $p < .001$). Similarly, Japanese men had lower inflammation than U.S. men ($b = -0.54$, $SE = 0.07$, $p < .001$). In the U.S., women had higher inflammation than men ($b = 0.24$, $SE = 0.05$, $p < .001$). In Japan, women had lower inflammation than men ($b = -0.26$, $SE = 0.09$, $p = .001$).

Sleep Dysfunction. The interaction between gender and loneliness was significant, such that the effect of loneliness on sleep dysfunction was higher in men than women ($b = -0.20$, $SE = 0.06$, $p = .002$). However, the simple effects of this interaction indicated that loneliness was not associated with sleep dysfunction for women ($b = -0.47$, $SE = 0.29$, $p = .107$) or men ($b = -0.27$, $SE = 0.29$, $p = .345$). There were no gender differences among those who were lonely ($b = -0.14$, $SE = 0.06$, $p = .021$) or not lonely ($b = 0.06$, $SE = 0.03$, $p = .063$).

3.4.3. Three-way interactions of loneliness, gender, and nationality on CVD indicators

We tested a model that included the three-way interaction of loneliness, gender, and nationality on CVD indicators. Though the model comparison test between the models that included and excluded the three-way interactions was significant ($\Delta\chi^2$ (16) = −68.64, $p < .001$), the three-way interactions were not significant (*p*s ≥ .530). So, for simplicity in reporting, we report the model parameters for the model with three-way interactions in Supplementary Results.

4. Discussion

Loneliness was prevalent and did not differ significantly between adults from the U.S. (25.4%) and Japan (20.8%). Loneliness in the Japanese sample was higher than expected, but the U.S. data were on par with previous studies (DiJulio et al., 2018).

Our expectation that differences in loneliness between the U.S. and Japan would be due, at least in part, to greater collectivism in Japan was not supported. We found no significant associations between collectivism and loneliness. Further, Japanese participants – recruited from Tokyo, a major Japanese city – reported less collectivism than U.S. participants. Urbanization of Eastern cultures encourages individualism and might free individuals from social constraints and social monitoring because there is greater anonymity living in a more populated, urban

setting (Ogihara, 2017; Yamagishi et al., 2012). In contrast, rural areas are more bound by social constraints and are more likely to be collectivistic (Yamawaki, 2012). Data regarding urbanity and rurality of participants' neighborhoods were not collected for the U.S. sample. Our results emphasize caution against equating nationality with cultural values and urge consideration of individual or regional differences in cultural values within national boundaries.

We did not find significant gender differences in loneliness. Whereas past findings on this issue are mixed, there is a tendency to find greater loneliness in men than women (Barreto et al., 2020; van den Broek, 2017). The assessment of loneliness might influence gender effects. Gender differences were reported in studies that used indirect measures of loneliness, like the UCLA Loneliness Scale (Russell, 1996). In contrast, the current study used a direct measure of loneliness. With a direct measure, men may be more reluctant to admit loneliness because they face greater risk of social rejection or shame than women (Borys and Perlman, 1985; Office for National Statistics, 2018). Thus, using a direct measure of loneliness might obscure gender differences found when indirect measures are used.

4.1. Loneliness and CVD indicators

Greater loneliness was associated with MetD, consistent with previous work reporting that loneliness is positively associated with metabolic syndrome, greater WC (Whisman, 2010), and higher BMI (Shiovitz-Ezra and Parag, 2019). These earlier data were largely from Western samples, whereas the current study included an Eastern sample.

That said, we found differences in the association between loneliness and MetD based on nationality such that the association was – contrary to expectations – weaker in Japan than in the U.S. Our hypothesis was admittedly exploratory, given that studies examining associations between loneliness and MetD has been mostly conducted in Western samples (e.g., Whisman, 2010). We only found one study about associations between social relationships and MetD in Japan, which found that social support was associated with less metabolic syndrome in Japanese men (Ikeda et al., 2011).

Further, collectivism did not moderate the associations between loneliness and CVD indicators. These are curious results because we predicted that loneliness would be worse for people higher in collectivism. Our expectation was based on data from a study that examined the moderating effect of collectivism on the association between loneliness and health in participants classified as collectivistic based on national-level collectivism (Beller and Wagner, 2020). Thus, results about the associations between collectivism, loneliness, and health were different – perhaps based in part – on how collectivism was measured.

Our study did not find a significant association between loneliness and inflammation. This result was curious because loneliness was positively associated with inflammation in a similar study – which used secondary data from another wave of MIDUS survey (Nersesian et al., 2018). There are several reasons results might differ between our study and Nersesian et al. (2018). Data in the two projects were collected at different time points, and Nersesian et al. (2018) used data within a period that was more stressful than data collected in the current study (i.e., 2008 economic recession). Finally, Nersesian et al. (2018) included a larger sample of Black participants than the current project, which may have contributed to greater variance in inflammation values due to racial differences in stress (Feagin, 2006).

Furthermore, inflammation can be measured in various ways. Loneliness was associated with inflammation among Japanese men, but the measure of inflammation was different than in our study (i.e., neutrophil-to-lymphocyte ratio rather than CRP; Koyama, 2021). Thus, our measure of inflammation might not have been the most sensitive measure for the Japanese sample.

Loneliness was more strongly associated with sleep dysfunction in men than women. Our results – if replicated – provide novel data about gender disparities in the adverse effects of loneliness. Given that few studies have reported gender differences for the association between loneliness and sleep, we are hesitant to speculate about our isolated finding – that loneliness may impact sleep in men more than women – that was not based in theory or found in other studies (Hom et al., 2020).

4.2. Limitations

Despite data indicating that our single-item loneliness measure is robust, it cannot fully capture the nuance and multidimensional nature of the loneliness construct (Mund et al., 2023). Further, our measure of collectivism may be misaligned with evolving conceptualizations of collectivism. Although the SCS measures interdependence, on which lower scores indicate greater collectivism, it does not measure other cultural components of collectivism found in Asian cultures, such as honoring the family and avoiding loss of social standing (Singelis, 1994). Future studies examining associations between collectivism and loneliness in Asian samples should consider using a measure that better accounts for Asian cultural values, like the Brief Collectivism Questionnaire (Lui and Rollock, 2018).

Sample characteristics limit generalizability. Over thirty-one percent of our U.S. sample had graduate degrees, more than double the national estimate (Ryan and Bauman, 2016). Further, U.S. participants were 82.1% white, compared to a national estimate of 62.2% in 2014 (Colby and Ortman, 2014). Whereas U.S. data were collected in multiple sites that included larger and smaller cities, the Japanese sample consisted of individuals who resided in Tokyo. The lack of participants from rural areas in Japan is a limitation of our study, potentially explaining the lack of national differences in collectivism. Participants in this study completed at least two waves of data collection and may reflect a subset of the population who are especially motivated to participate in research, potentially limiting the generalizability of our findings (Price et al., 2016). Further, given the cross-sectional nature of our study, we could not infer any causal relationships between loneliness and CVD indicators.

5. Conclusions

This study provides new evidence on how nationality and individual cultural values impact the associations between loneliness and CVD indicators. Loneliness predicted metabolic dysfunction for U.S. – but not Japanese – adults. Despite common assumptions that Japan is more collectivistic (Oyserman et al., 2002) and less lonely (DiJulio et al., 2018) than the U.S., Japanese participants reported lower collectivism than U.S. participants and comparable loneliness prevalence. These unexpected findings might be because Japanese participants were from urban Tokyo, whereas U.S. participants were from multiple U.S. regions. Our results point to the need for future research on culture and loneliness to include measures of collectivism in different geographic regions within nations.

CRediT authorship contribution statement

Eleni A. Kapoulea: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Visualization. **Rebecca E. Ready:** Conceptualization, Methodology, Resources, Writing – review & editing, Supervision. **Joel C. Ginn:** Conceptualization, Methodology, Formal analysis, Writing – review & editing.

Declaration of competing interest

We have no conflicts of interest to disclose.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2023.116299.

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