Title: Optimism and Longevity Among Japanese Older Adults

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Short title: Optimism and Longevity in Japan

Abstract

Background: Optimism has been linked to better physical health across various outcomes, including greater longevity. However, most evidence is from Western populations, leaving it unclear whether these relationships may generalize to other cultural backgrounds. Using secondary data analysis, we evaluated the associations of optimism among older Japanese adults.

Methods: Data were from a nationwide cohort study of Japanese older adults aged ≥65 years (Japan Gerontological Evaluation Study; n = 10,472). In 2010, optimism and relevant covariates (i.e., sociodemographic factors, physical health conditions, depressive symptoms, and health behaviors) were self-reported. Optimism was measured using the Japanese version of the Life Orientation Test-Revised (LOT-R). Lifespan was determined using mortality information from the public long-term care insurance database through 2017 (7-year follow-up). Accelerated failure time models examined optimism (quintiles or standardized continuous scores) in relation to percent differences in lifespan. Potential effect modification by gender, income, and education was also investigated.

Results: Overall, 733 individuals (7%) died during the follow-up period. Neither continuous nor categorical levels of optimism were associated with lifespan after progressive adjustment for covariates (e.g., in fully-adjusted models: percent differences in lifespan per 1-SD increase in continuous optimism scores= −1.2%, 95%CI: −3.4, 1.1 higher versus lower optimism quintiles= -4.1%, 95%CI: -11.2, 3.6). The association between optimism and lifespan was null across all sociodemographic strata as well.

Conclusion: Contrary to the existing evidence from Western populations, optimism was unrelated to longevity among Japanese older adults. The association between optimism, as evaluated by the LOT-R, and longevity may differ across cultural contexts.

Keywords (between 4 to 6): culture, ethnicity, mortality, optimism, psychological well-being, race

INTRODUCTION

While most epidemiologic research focuses on identifying factors associated with increased disease risk, emerging evidence also advocates considering positive health assets—that is, positive social, psychological, and environmental factors that promote better physical health (Trudel-Fitzgerald, Millstein, et al., 2019; VanderWeele et al., 2020). Dispositional optimism, the tendency to believe that good events will occur (Boehm & Kubzansky, 2012; Carver et al., 2010), is one such positive health asset. Studies suggest that higher levels of optimism are associated with lower risk of chronic diseases and mortality (Rasmussen et al., 2009; Rozanski et al., 2019; Trudel-Fitzgerald, Millstein, et al., 2019), as well as with increased likelihood of healthy aging, characterized by the absence of major chronic diseases, physical and cognitive impairment (James et al., 2019; Kim et al., 2019). Recent studies further showed that higher (versus lower) optimism levels were associated with up to 10% greater lifespan (L. O. Lee et al., 2019; Revelas et al., 2018). Yet, most of this evidence is from Western populations, leaving it unclear whether these relationships may generalize to non-Western populations. In parallel, even within the U.S., the strength of the association between optimism and health outcomes, including mortality, differs across racial/ethnic subgroups (Graham & Pinto, 2019; Kubzansky et al., 2020), reinforcing the idea that the optimism-health association can be heterogeneous across different cultural groups around the world. In Japan, a non-Western population known to have some of the longest life expectancies worldwide, some work has considered whether life enjoyment or a sense that life is worth living is associated with mortality in Japan (Shirai et al., 2009). However, to our knowledge, no studies have evaluated optimism's relationship with longevity in this population.

There are at least two potential reasons why the optimism-health association may differ by culture, and more specifically between the U.S. and Japan. First, optimism scores tend to be distributed differently across populations with different cultural backgrounds. Similarly, studies across 61countries, which measure optimism using the same measure of dispositional optimism, the Life Orientation Test Revised (LOT-R), showed that the average level of optimism is lower in Japan than in Western countries (Baranski et al., 2021; Fischer & Chalmers, 2008; Gallagher et al., 2013). In some non-Western populations, like Japan where elevated optimism is overall less prevalent, the related health benefits may not be as clear because higher optimism carries a different meaning compared to Western populations where elevated optimism is more common. More specifically, non-Western populations tend to value harmonious interdependence with others; as a result, individuals with high optimism in those countries may be regarded as "outliers" and menaces to the harmony, ending up getting fewer health benefits from societies (e.g., social support from peers) (Boylan et al., 2017; Hruschka et al., 2018; Kozela et al., 2017; Medin et al., 2017). Second, the adoption of health-promoting behavioral factors and their association with optimism may differ across cultures (Baruth et al., 2011; Boehm et al., 2018; Progovac et al., 2017; Serlachius et al., 2015; Trudel-Fitzgerald, James, et al., 2019). For example, although studies from the US or UK found higher optimism levels were associated with higher physical activity levels (Baruth et al., 2011; Progovac et al., 2017; Trudel-Fitzgerald, James, et al., 2019), studies among Chinese students or Finnish young adults did not find

significant associations between higher optimism levels and either duration of exercise or engaging in moderate/vigorous physical activity (Ramsay et al., 2015; Serlachius et al., 2015). Therefore, it is plausible that the optimism-health association is heterogeneous across racial and cultural subgroups. However, most existing evidence stems from studies of Western populations (primarily the U.S.), preventing the generalization of results to populations of different cultural backgrounds, including non-Western ones (e.g., Japan).

This study addressed this scientific gap by examining the association between optimism and lifespan among Japanese older adults over a 7-year follow-up period. Data were from a Japanese nationwide cohort study of older adults aged 65 years or above. Following prior studies (James et al., 2019; Kim et al., 2019; L. O. Lee et al., 2019), participants' sociodemographic factors, physical health conditions, and behavioral-related factors assessed at baseline were considered as covariates. Given known relationships of psychological distress with both optimism and mortality, to evaluate whether optimism has an association with lifespan independently of psychological distress we further controlled for depressive symptoms, also assessed at baseline. Lastly, we evaluated potential effect modification by gender, income, and education levels, given previous research suggesting that average lifespan and optimism levels can vary by these sociodemographic factors (Baranski et al., 2021; Graham & Pinto, 2019). We hypothesized that higher optimism levels are associated with a longer lifespan in this Japanese cohort of older adults, but to a smaller extent compared to what has been observed in Western countries.

METHODS

Study population

The Japan Gerontological Evaluation Study (JAGES) is a nationwide longitudinal study of healthy aging targeting physically and cognitively independent Japanese adults aged ≥65. JAGES distributed the baseline self-administered questionnaire by mail to 169,215 individuals residing in the 39 municipalities of Japan in 2010. The baseline questionnaire measured sociodemographic factors, physical health conditions, depressive symptoms, and health behaviors. Approximately one-fifth (n = 34,570) were randomly selected to receive a supplement to the baseline survey that included 6 items assessing optimism. Of those individuals, 24,209 returned the baseline questionnaire (70% response rate). Among the 39 municipalities that participated in the JAGES survey, 13 municipalities agreed to provide mortality data through 2017 and the survey data was then linked to mortality information based on national death certificates from the national long-term care insurance database for participating municipalities (Tamiya et al., 2011). The resulting sample size was 11,915 (49% of the overall respondents to the supplement). To reduce concerns about reverse causation (i.e., experience/report of optimism might be influenced by pre-existing health conditions), we further excluded participants who died ≤2 years of baseline (n = 8). We also excluded individuals missing ≥4 items on the optimism measure (n = 1,435), leading to an analytic sample of 10,472 individuals (see Figure 1 for the flowchart). Covariates generally had a low proportion of missing data (<10%), except for age (18%), sex (18%), household income (20%), and depression (16%).

Completion and return of the self-administered questionnaire indicated consent to participate in the study. The study obtained ethics approval from the Ethics Committees in the Research of Human Subjects at Nihon Fukushi University and Chiba University Faculty of Medicine.

Measures

Optimism

Optimism was assessed in 2010 using the validated Japanese version of the Life Orientation Test-Revised (LOT-R) (Nakano, 2004). Participants reported the degree to which they agreed to 6 statements assessing optimism (e.g., "In uncertain times, I usually expect the best") with responses on a 5-point Likert scale ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"). While the scale's internal consistency was acceptable in the original validation study ($\alpha = 0.62$) (Nakano, 2004), it was somewhat lower in our analytic sample ($\alpha = 0.56$). Therefore, we eliminated the item that most reduced the Cronbach's alpha ("When it seems like something bad will happen, it usually does"), which improved the internal consistency somewhat ($\alpha = 0.60$).

Because optimism is best characterized by both endorsing positively-worded items and rejecting negatively worded items, following prior recommendations, we did not use the subscales that focused only on positively or negatively worded items (Segerstrom et al., 2011). After reverse-coding negatively worded items, responses were summed across the retained five items to create a total score ranging from 5 to 25, where a higher score indicates greater optimism. For participants who were missing ≤3 items (n = 963; the majority [70%] of participants with missing data were missing only 1 item), the missing values were imputed using the mean score of the completed items for the same individual. We standardized the continuous optimism scores (mean = 0, standard deviation [SD] = 1) to facilitate comparisons of effect sizes across studies. To assess possible non-linearity in the relationship between optimism and lifespan, we also categorized the continuous LOT-R scores into quintiles (Q1 = 5–14 [21%], Q2 = 15 [30%], Q3 = 16 [20%], Q4 = 17 [12%], Q5 = 18–25 [17%]). We note, however, that the distribution was highly constrained, resulting in several quintiles comprised of a single score.

147 ***Longevity***

148 We considered percent changes in lifespan (time from study baseline to death onset) as
149 the indicator of longevity. Deaths during the follow-up period from 2010 to 2017 were
150 ascertained by linking the cohort participants to mortality records based on death certificates
151 from the national long-term care insurance database (Tamiya et al., 2011).

152 ***Covariates***

153 Following prior studies (Hernandez et al., 2015; James et al., 2019; Kim et al., 2017,
154 2019; L. O. Lee et al., 2019; Rozanski et al., 2019), participants' sociodemographic factors,
155 health conditions, and behavioral-related factors at baseline were considered as covariates. All
156 covariates were assessed via self-report. Sociodemographic factors were considered as potential
157 confounders in the optimism-longevity association and included age (years), gender
158 (female/male), education (≤9, 10–12, or ≥13 years of schooling), annual equivalent household
159 income (continuous), and marital status (married, single/divorced, or widowed). Health
160 conditions were also considered as potential confounders and included depressive symptoms and
161 a range of physical health conditions (yes, no). Depressive symptoms were assessed using the
162 Japanese version of the Geriatric Depression Scale (range = 1–15; $\alpha = 0.82$) (Burke et al., 1991)
163 and, following previous research (Wada et al., 2003), we used a cut-off of ≥5 to define clinical
164 levels of depressive symptoms. Participants were categorized as having at least 1 physical health
165 condition (versus none) if they indicated receiving current treatment for any of 6 major physical
166 health conditions (i.e., hypertension, diabetes, cancer, stroke, heart diseases, or respiratory
167 diseases) as a proxy for health status. Lastly, behavior-related factors, which may either
168 confound or lie on the pathway of the optimism-longevity association, included physical activity,
169 body mass index (BMI), vegetable and fruit consumption, current smoking status (never, former,

or current smoker), and physical exam for screening purposes in the past year (yes/no). Physical activity was assessed with a single item asking if participants walked >30 minutes/day during the past month (yes, no). BMI (kg/m^2) was calculated using self-reported weight and height and used as a continuous variable. Participants reported their average daily frequency of vegetables and fruits consumption over the past month (≥1 time/day versus <1 time/day).

Statistical analysis

We fitted accelerated failure time (AFT) models with a Weibull distribution to examine associations between optimism and lifespan over the 7-year follow-up period. Unlike Cox proportional hazard model, which is based on the hazard function, AFT model is based on the survival curve and can model survival time directly to provide the proportion of changes in the outcome in relation to changes in the exposure levels (Swindell, 2009). We calculated the percent differences in lifespan and 95% confidence intervals (CI) across optimism levels by applying the following formula: $100*(e^{\beta} - 1)$, where β is an estimate for optimism from the AFT model.

Following prior work in this area, four models sequentially adjusting for covariates were evaluated. Model 1 included age only. Model 2 added other sociodemographic variables (i.e., gender, marital status, education, and income). Model 3, our core model, additionally controlled for baseline health conditions, including depressive symptoms. Model 4 further adjusted for baseline behavior-related factors. In separate model sets, we considered optimism as a continuous (per 1-SD increase) or categorical (quintile; Q1 [reference group] through Q5) variable. Because lifespan and optimism levels may differ by gender, income, and education (11,14), we also ran separate models evaluating potential effect modification by adding an

192 interaction term between each of these factors and continuous standardized levels of optimism to
193 the core model (Model 3).
194 To mitigate potential biases caused by missing data in covariates, which ranged from 3%
195 to 20%, we performed multiple imputations by chained equation. We used the "MICE" R
196 package to create 10 imputed data sets and combined estimates from each imputed data set using
197 the Rubin's rule (34). As a sensitivity analysis, we also conducted a complete-case analysis (n =
198 4,595; 44% of the full analytic sample). All analyses were performed using R Statistical
199 Software version 3.6.2.
200

RESULTS

Baseline characteristics

In the analytic sample (n = 10,472), 733 deaths (7.0%) occurred over the 7-year follow-up period. Mean time-to-death was 1,661 days (SD = 390). Table 1 summarizes the distribution of baseline characteristics by optimism quintiles. Although sociodemographic characteristics, physical health conditions, and behavior-related factors were generally comparable across optimism levels, participants with higher optimism levels reported lower prevalence of depressive symptoms (Q1 = 38%; Q2 = 25%; Q3 = 20%; Q4 = 14%; Q5 = 11%). Supplementary Table 1 compares sociodemographic characteristics of the analytic sample (n = 10,472) with those of the participants excluded due to missing data on the optimism items or to death occurring within 2 years after baseline (n = 1,443). Participants from the analytic sample tended to be more highly educated (≥13 years: 17% versus 9% in the excluded individuals), married (71% versus 61%), and not depressed (61% versus 48%) (see Supplementary Table 1).

Optimism and lifespan

Table 2 presents the results from the AFT models evaluating the relationship between optimism levels and percent differences in lifespan. We observed no association between optimism quintiles and lifespan in the age-adjusted model. For example, individuals with the highest (Q5) versus lowest (Q1) optimism levels had 4.0% greater lifespan (95%CI: −3.4, 12.0; i.e., the time from study baseline to death date was 4.0% longer). Further, in other models sequentially adjusting for sociodemographic factors, health conditions, and behavior-related factors (e.g., the fully-adjusted model: Q5 versus Q1 = −4.1, 95% CI: −11.2, 3.6) and confidence intervals were wide across all models, none of which reached statistical significance. Findings

were similar when we considered optimism as a continuous variable. For example, in the fully-adjusted model, 1-SD increase in optimism was associated with 1.2 % decrease in lifespan, again with wide confidence intervals (95%CI; −3.4, 1.1). There was no evidence of effect modification of the optimism-lifespan relationship by gender, income, or education (all *p*'s >0.10; Supplementary Table 2). The complete-case analysis similarly showed null associations between optimism and longevity across the models (Supplementary Table 3).

DISCUSSION

Prior evidence linking higher optimism and longevity has been primarily based on data from the Western populations (L. O. Lee et al., 2019; Rozanski et al., 2019). In this study, we investigated whether the association of higher optimism with longer lifespan can be replicated among Japanese older adults. We found no evidence for this association after adjustment for a series of covariates, all assessed at baseline. We also found no evidence of effect modification by gender, income, and education.

While our findings are inconsistent with the existing evidence linking optimism and longevity among U.S. older adults (L. O. Lee et al., 2019), prior studies suggest that other psychological assets are associated with lower mortality in both Japanese and Western populations (Alimujiang et al., 2019; Trudel-Fitzgerald, Millstein, et al., 2019). For instance, in a prospective study of 88,175 Japanese midlife and older adults, lower levels of life enjoyment were associated with increased mortality risk, above and beyond sociodemographic factors, physical health conditions and behaviors, and psychological distress (Shirai et al., 2009). Two other large prospective studies of Japanese midlife and older adults also considered *ikigai* – a Japanese construct capturing positive affect and purpose in life – and found that higher versus

lower *ikigai* levels were associated with decreased mortality risk, beyond established risk factors (Sone et al., 2008; Tanno et al., 2009). There are at least three potential explanations for our finding that optimism, unlike other psychological assets, was not associated with longevity in older adults from the JAGES cohort.

The first explanation pertains to the distribution of optimism in our sample. More than half of the participants (60%) reported optimism scores between 15 and 17 (Supplementary Figure 1). This lack of variability may have contributed to the null association observed between optimism and lifespan in this study. Furthermore, the mean optimism score in our sample of Japanese older adults was lower than those from the studies of Western countries, which is consistent with prior evidence comparing optimism levels from multiple nations, including Japan and Western countries (Baranski et al., 2021; Gallagher et al., 2013). In Western countries, more versus less optimistic individuals tend to receive more social support and engage in more favorable health behaviors, which in turn may promote greater lifespan (L. O. Lee et al., 2019). On the other hand, in non-Western countries that focus on more harmonious interdependence with others like Japan (Boylan et al., 2017; Carver et al., 2010; Uchida & Kitayama, 2009), the most optimistic individuals, who deviate from the population average, can be considered as "outliers". As a result, they may be *less* socially integrated, which can lead to experiencing more stressors, worse health outcomes, and shorter lifespan (Leigh-Hunt et al., 2017; Trudel-Fitzgerald et al., 2020).

Secondly, our optimism measure may not have captured the most relevant facets of optimism among the Japanese. Optimism has multiple facets (Forgeard & Seligman, 2012; Jefferson et al., 2017) and may be derived from several sources. For example, higher optimism may be i) grounded in the actual resources one has (e.g., knowing he/she has a stable income,

access to health care, high levels of family support); ii) due to a sense that one is effective (e.g., when he/she engages in specific activities or efforts, they are usually successful); or ii) based on unrealistic thinking (e.g., believing one is immortal). The LOT-R scale may have failed to capture the most relevant facet of optimism for these older individuals in Japan (Gillham et al., 2001; Peterson & Steen, 2009). Future research evaluating the role of diverse facets of optimism in longevity among Japanese is warranted. Relatedly, developing culturally-sensitive measures of optimism may be necessary.

Lastly, between-country differences in the distributions of mediators linking optimism and longevity may be at play. The adoption of healthier behaviors (e.g., not smoking, engaging in physical activity) is a potential pathway underlying the optimism-health association (Baruth et al., 2011; Boehm et al., 2018; Progovac et al., 2017; Serlachius et al., 2015). Evidence suggests that some of these healthy behaviors are less prevalent in Japan compared to the Western populations, partly due to cultural (e.g., lack of clear social norms against smoking) (East et al., 2021) and structural factors (e.g., limited walkability) (Hanibuchi et al., 2011; Smith et al., 2017). Similarly, Japanese versus U.S. adults are less likely to engage in adaptive coping strategies, a potential mediator of the optimism-health association (Chang, n.d.; H. Lee & Mason, 2013; Nes & Segerstrom, 2006). Thus, positive cultural, structural, and personal resources may be less strongly related to optimism levels in Japanese compared to U.S. adults, leading to weaker associations of optimism with the mediators and, ultimately, longevity.

This study has several limitations. First, despite our efforts to increase the reliability of the LOT-R in our sample by eliminating one item (original Cronbach's alpha = 0.56, Cronbach's alpha after excluding one item= 0.60), the internal consistency reliability coefficient remained low compared to those obtained among Western populations (e.g., α varying from 0.75 to 0.79

among three U.S. samples of midlife/older adults; (Boehm et al., 2015; Kim et al., 2017; Trudel-Fitzgerald, James, et al., 2019). Moreover, the internal consistency reliability coefficient appeared relatively low compared to what was found in the validation study of the Japanese LOT-R conducted among college student sample (alpha = 0.62). The relatively low internal consistency in our study suggests that our optimism measure may be less reliable, which may in part explain the null results. Second, self-reported measures of behavior-related factors and physical health conditions were not validated against objective metrics. Third, our results may be biased when the missing at random assumption is violated, although we used multiple imputation to address potential selection bias due to missing data. Notably, age and sex variables were not missing at random. However, when we compared the characteristics of the sample excluding those who had missing age and sex (n=8,554) versus the overall analytic sample (n=10,472), the two samples' distributions of the exposure and outcome variables were very similar (Supplementary Table 4), indicating that the chance of systematic missing in age and sex causing non-causal association due to selection bias is minimal (Hernán et al., 2004). Lastly, because JAGES participants are healthy adults of ≥65 years old, these results may not generalize to less healthy older Japanese populations and non-Western younger individuals. Our study also has several strengths. First, data were collected prospectively in a nationwide sample of older adults. Second, mortality was obtained from a national database tracking mortality with high fidelity (Tamiya et al., 2011). Third, we considered a wide range of potential confounders and mechanistic pathways, including sociodemographic factors, physical health conditions, depression, and behavior-related factors.

CONCLUSION

This is one of the first studies to evaluate optimism's longitudinal association with lifespan in Japan. Contrary to previous findings in Western populations, our study found no evidence of an association between optimism and lifespan among Japanese older adults. Null findings were also obtained when testing the association within gender, income, and education subgroups. These results highlight the importance of considering cultural differences regarding what may be considered a health asset or how it might be distributed when investigating associations between psychological assets and longevity in varied populations.

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