Stress-related growth and health in Japanese people living with HIV

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日本国内HIV陽性者におけるストレス関連成長と健康

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ABSTRACT

Objectives: For Japanese people living with HIV, this study aimed at the following: verifying the three-factor model of stress-related growth scales; confirming the impact of stress-related growth on mental health and physical symptoms; and determining differences in the effects of stress-related growth on health by time since HIV diagnosis.

Methods: A cross-sectional anonymous self-administered online survey "HIV Futures Japan Project" that was prepared on the basis of the participatory research method was conducted from July 2013 to February 2014 and from December 2016 to July 2017 for all Japanese web users living with HIV. We analyzed the data of 1,422 participants who responded regarding the number of years since diagnosis and where transmission was sexual.

Results: Stress-related growth comprises three factors: self-perception, interpersonal relationships, and philosophy of life. In the group over 4 years since diagnosis, logistic and Poisson regression analysis simultaneously including all the scales showed a positive effect; in the group with less than 4 years since diagnosis, such an association was found only for self-perception. In the group with over 4 years since diagnosis, positive growth in interpersonal relationships and self-perception led to reduced somatic symptoms. When the group with less than 4 years since diagnosis was included, no correlation was evident with philosophy of life; positive changes in interpersonal relationships produced increased physical symptoms.

Conclusions: For people living with HIV, it was found that obtaining positive changes in relationships with others was particularly important in producing good mental and physical health for respondents.

要　旨

目的：日本人HIV陽性者を対象とし、ストレス関連成長スケールの３因子モデルを検証すること、およびストレス関連の成長が精神的健康と身体的症状に及ぼす影響を確認すること、および、HIV陽性判明以降の時期によるストレス関連の成長と健康との関連の違いを検討することを目的とした。

方法：当事者参加型リサーチに基づいてオンライン調査法で実施されたHIV Futures Japanデータを用いた。2013年７月から2014年２月まで、および2016年12月から2017年７月まで、HIV陽性者であるWebユーザーに対して実施した。HIV陽性判明後の年数が明確であり、感染経路が性的であった1,422人を分析した。

結果：先行理論に基づきストレス関連の成長的変化は、自己認識、対人関係、人生観の３つの要素で構成された。HIV陽性判明４年以上のグループでは、ロジスティック回帰分析とポアソン回帰分析において、すべての要素のポジティブな効果が示された。診断から４年未満のグループでは、自己認識のみで、有意な関連がみられた。HIV陽性判明後４年以上経過したグループでは、対人関係と自己認識のポジティブな成長が身体症状の少なさに関連した。HIV陽性判明後４年未満のグループでは、人生観との関連はみられなかったが、対人関係のポジティブな変化は、身体的

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症状の多さに関連した。

結論：HIV陽性者では、特に、他者との関係性のポジティブな変化を得ることが、回答者のメンタルヘルスや身体健康の良好さを生み出す上で重要であることがわかった。

INTRODUCTION

In Japan, the number of new human immuno-deficiency virus（HIV）/acquired immunodeficiency syndrome（AIDS）cases was 1,317 in 2018（1,389 in 2017）[1]. The total number of reports for 1985–2018 was 30,149（including those who subsequently died）[1]. Evidently, the number of HIV/AIDS patients is increasing annually in Japan.

The issue of the stigma surrounding HIV has been reported in numerous countries; it is apparent that HIV infection imposes a mental and physical burden[2-9]. In the most recent Japanese survey, 85.2% of participants stated that it was unsafe to reveal to others that they were HIV positive[10]; 65.9% declared that they were striving to ensure that no one around them realized their condition. These findings demonstrate that a significant stigma related to HIV[10] persists, which imposes a heavy burden.

Consequently, stress is high among people living with HIV（PLWH）in Japan. PLWH in Japan have mental health problems[11, 12], including a higher proportion of anxiety and depression than the general population[10]. Thus, there is an urgent need to develop appropriate solutions.

These stressful conditions can damage the mental health of many individuals; however, some PLWH manage to stay healthy and even flourish[10]. Such concepts as stress-related growth（SRG）or post-traumatic growth（PTG）have recently received attention as explanations for this phenomenon[13, 14]. SRG is defined as "actual or veridical changes that people have made in relation to their experience with an identified stressful or traumatic event"[13]. SRG and PTG are similar in that both concepts reflect true developmental change due to stress[15]. According to Tedeschi and Calhoun, change occurs in the following three categories: self-perception; interpersonal relationships; and philosophy of life[16]. PTG is a form of growth that may occur as a result of high levels of stress and "seismic" events（e.g., natural disasters and war）. By contrast, SRG arises from traumatic events as well as from chronic stressors（e.g., everyday stressor and care-giving responsibilities）[17-19]; thus, the concept of SRG covers a broader range of phenomena. PTG was reported to take "several years"[20]. The duration of SRG is unknown, but it may take longer due to the effects of chronic stress exposure.

Systematic reviews revealed that SRG is correlated with perceived health, especially mental health[21, 22]. Furthermore, a systematic review find out that SRG is not related to depression or anxiety, but to positive well-being and intrusive-avoidant thoughts[23]. However, compared with the number of studies on SRG and mental health, little research has investigated the correlation between SRG and physical health. Most studies found that SRG is related to improved physical health[24]. For example, Affleck et al. determined that among participants who reported SRG, the likelihood of subsequently suffering a heart attack was significantly lower[25]. The mechanism of the association between SRG and physical health may involve mental and biological factors, such as stress-coping strategies and responses to biological stress[17]. However, there is a lack of Japanese studies in this area.

Some studies have investigated SRG in PLWH. For example, Milam found that in PLWH with high SRG, objective biological indicators, such as CD 4 cell levels and disease progression, may proceed more slowly[26]. Updegraff et al. observed that a positive change with SRG was negatively associated with depressive symptoms; they reported it was not associated with anxiety and general health among American female PLWH. The authors found that a negative change with SRG was positively associated with depressive symptoms and anxiety, and it was negatively associated with general health[27].

Using an original SRGS with American female PLWH, Siegel et al. determined that SRG was cor-related with a lack of depressed moods[28]. In a study of Indian PLWH, SRG mediated the negative relationship between religiously and spirituality and depression. It was shown that depression was reduced by obtaining SRG[29]. Further, an investigation of the same group of participants verified that SRG had a direct effect on depression and exerted a stress-buffering effect; SRG was found not to have an association with physical health[30]. A recent review reported that positive reappraisal coping in PLWH plays an important role in promoting health and strengthening self-management[31]. Sawyer et al. performed a meta-analysis of 38 studies on SRG in subjects with cancer and HIV（eight studies on HIV）.

They reported that SRG had a positive effect on positive mental health and physical health; it had a negative effect on negative mental health[32].

From the above studies, SRG is evidently a key concept in health promotion (including mental health) among PLWH. It appears that it will become increasingly important for support for PLWH to focus on SRG. We consider there to be the following three problems in assessing SRG in PLWH. First, the relationship between SRG and physical or somatic symptoms among PLWH has not been sufficiently researched[33]. According to one systematic review, there is no a consensus on the relationship between SRG and mental health[33].

Second, with regard to measuring SRG, as described above, most investigations have used SRG measurement tools that are limited to positive changes, such as growth and benefit. However, some studies have reported that negative cognitive changes and experiences of loss apparently occur in response to illness[34]. Additionally, it has been asserted that negative survey items should be used as filler items in studies on growth and benefit owing to the high degree of social desirability bias[35]. When psychological strength, partner bonding, and other such concepts are investigated, they have been found to grow stronger, become weaker, or remain the same after a traumatic event. Such cognitive changes could therefore be measured on a single axis with "no change" as the starting point. In fact, in the study on Japanese PLWH where HIV was caused by contaminated blood products, mentioned above, SRG was measured on a single axis[36].

Third, many studies have treated SRG as a single factor; thus, the relationship among its component elements have hitherto not been sufficiently elucidated. For example, the three elements suggested by Tedeschi and Calhoun (self-perception, interpersonal relationships, and philosophy of life) are strongly cor-related as sub-concepts in the construct of the growth concept[16]. However, it is possible that those elements may function independently, i.e., some people may exhibit improvements in terms of self-perception but deterioration with interpersonal relationships. Further, an examination of the subscales should clarify cor-relations among them; it should also allow additional practical applications by providing more specific and concrete conceptual details.

On the basis of the above discussion, this study aimed to clarify the following three points among Japanese people living with HIV. First, we aimed to verify the three-factor model of stress-related growth scales in order to confirm configural and metric invariance of the factors by the number of years after the diagnosis of HIV infection. Second, we attempted to confirm the relationship impact between subscales of stress-related growth and mental health. Third, we aimed to confirm the relationships between subscales of stress-related growth and somatic symptoms. We also examined differences in the effects of stress-related growth on health by time since HIV diagnosis.

METHODS

Participants and methods

This cross-sectional study employed data from the first and second HIV Futures Japan (HFJ) nationwide surveys (HFJ-wave 1 and HFJ-wave 2) of Japanese people living with HIV (PLWH). HFJ-wave 1 was an anonymous self-administered Web survey conducted from July 2013 to February 2014. Three authors of this paper, including the corresponding author, are members of the HFJ steering committee. A participatory research method was used to implement the survey; advertising and recruiting were achieved through support groups for PLWH, a public Twitter account, a public Facebook account, and 400 HIV treatment institutions across Japan. Participatory research is the co-construction of studies among researchers, people affected by the issues under study (e.g. patients, community members), and/or decision makers who apply research findings (e.g., health managers, policy-makers, and community leaders)[37-39]. PLWH participated in the steering committee and organized a PLWH group consisting of 15 people to discuss the contents of the questionnaire with the researchers. The PLWH group played a leading role in recruiting survey subjects. In addition, a joint meeting was held with the PLWH and researcher groups to share the results of data analysis, and the PLWH group commented on the results. Responses were obtained from 1,095 people; after data cleaning, 913 valid responses remained. HFJ-wave 2 was implemented from December 2016 to July 2017 using the same survey format as that for HFJ-wave1; 1,110 individuals responded, resulting in 1,038 valid responses. Thereafter, data cleaning was performed to remove cases where there were few answers or cases where the answers were incomplete such as cases where all the answer numbers were the same.

The results from 579 individuals who responded to HFJ-wave2 but did not respond to HFJ-wave1 were combined with the 913 valid responses from HFJ-wave1. We set the following three criteria for

exclusion from HFJ data. First, wave 2 respondents who answered wave1 were excluded. Second, persons whose years since HIV diagnosis was unknown were excluded. Lastly, those with a transmission route other than sexual were excluded. As these surveys were open entry-type online surveys, the recovery rate was unable to be calculated. We then analyzed the data from 1,422 individuals. The mean age (SD) was 38.6 (8.3) years.

In a 2013 survey conducted through medical institutions on Japanese HIV-positive participants (n =1,100), the average age was 44.6 years, with 24.3% of participants having a time since HIV diagnosis of less than 3 years[41]. The participants in the present study (average age, 36.6 years; with 32.6% of participants having a time since HIV diagnosis of less than 3 years) were somewhat younger and learned about their diagnoses more recently. In the earlier survey, the participants were regular outpatients at nine Japanese central medical institutions; however, our sample included participants who belonged to a different group (e.g., those who found out they were infected and undergoing treatment) from those in the previous study. We consider our participants to be representative of the target population; they were all living in the same Japanese prefecture, seeing a doctor at a non-central medical institution, and included untreated individuals.

Variables
Stress-related growth

We used the perceived positive and negative change scale based on SRG and PTG theory to assess both positive and negative changes in Japanese hemophiliac patients infected with HIV by contaminated blood products[36]. We applied the scale to measure SRG for PLWH with sexual transmission. The scale was based on the theory of Tedeschi and Calhoun regarding the three elements of self-perception (SP), interpersonal relationships (IR), and philosophy of life (PL)[16]. The scale measures the following 10 attributes with respect to the time the respondent was infected with HIV to the time of the survey: confidence to get through life (SP1); mental strength (SP2); purpose in life/life enjoyment (SP3); way of thinking about things (SP4); way of thinking about daily life (PL1); concern for health (PL2); desire to be useful to society and others (PL3); ties with friends (IR1); trustworthy friends and acquaintances (IR2); and partner or family ties (IR3). In this study, content validity was confirmed through repeated discussions between researchers and PLWH. For example, regarding the family tie

item, there were many opinions that PLWH are not applicable because they include many sexual minorities and are often estranged from the family. On the other hand, there was an opinion that it was necessary to mention the relationship with same-sex partners. Therefore, in this study, this item was described as partner and family ties. We measured each attribute using a Likert scale with a single axis and two negative and positive poles. For example, the scale featured the following five-level item: "Since I was diagnosed with HIV, I have grown psychologically weaker (−2), slightly weaker (−1), neither weaker nor stronger (0), slightly stronger (+1), or stronger (+2)." We calculated the mean score of each subscale.

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) was developed to screen for depression and anxiety in patients with physical diseases, its reliability and validity have been demonstrated[40]. It comprises seven items, with three levels for both depression (HADS-D) and anxiety (HADS-A)[40]. We used the Japanese version in the present study; as in previous investigations, we set the cutoff at 11 points[41]. The prevalence of those conditions in Japan is 4.8% for anxiety disorder and 2.9% for depression[41].

Number of physical symptoms

The respondents were asked about 41 concerning physical symptoms (such as fatigue, headache, vertigo, stiff shoulder, limb numbness, audiovisual symptoms, gastrointestinal symptoms, motor apparatus symptoms, and urological symptoms)[42]. In our analysis, we used count values for those responses.

Control variables

Sexuality. We generated three categories: female, male heterosexual, and other. The sexual orientation of all females was heterosexual. Therefore, as a control variable, only males were divided into three categories by their sexual orientation.

Age. At the time of the survey, respondents were asked their age. We treated this as a continuous variable.

Years since HIV diagnosis. Respondents were asked, "When did you learn you were HIV positive?" We calculated the number of years from HIV diagnosis to the time of the survey.

Educational level. We established three categories: middle or high school; vocational school, junior college, or technical college; and university or graduate school.

Annual income. We categorized personal annual income as follows: <1 million yen（about US $9,090）; 1 million to<3 million yen（about $27,200）; 3 million to<5 million yen（about $45,450）; 5 million to<8 million yen（about $72,700）; and 8 million yen or more.

Analysis methods

In our analysis, we divided respondents into two groups based on duration since HIV diagnosis: under 4 years and over 4 years. This was because, theoretically, the extent of generated growth differs both quantitatively and qualitatively according to the length of time since a traumatic event[43]. Another reason was to match the sizes of both groups because the median duration since HIV diagnosis in this sample was 4.0 years. Lastly, we based our approach on the experience of people who support PLWH in Japan: they generally offer assistance under the assumption that it takes at least 3–4 years to produce a change in patients'self-management.

Next, regarding the perceived positive and negative growth scale, we conducted a confirmatory factor analysis on the three hypothetical categories of factors that were created. For each item, the distribution and outliers were confirmed by a histogram and box-plot, and the distribution did not deviate from the normal distribution. Maximum likelihood estimation was performed for missing values. In the confirmatory factor analysis, we set the above-mentioned three-factor structural model of self-perception, interpersonal relationships, and philosophy of life as a hypothetical model based on the previous theory. A multi-group analysis was performed on groups with less than and greater than 4 years since HIV diagnosis. To determine goodness of fit, we compared the following: a model with open parameters for both groups; a model with equality constraints on the covariance and path coefficient values for both groups; and a model with equality constraints on the error variance in addition to the covariance and path coefficient. We used the Tucker-Lewis coefficient（TLI）, comparative fit index（CFI）, and root mean square error of approximation （RMSEA）values as indicators of fit.

Subsequently, we determined the psychological scale characteristics of the three perceived positive and negative growth subscales. We employed Cronbach's α coefficient for internal consistency. The allowable range of α coefficient was based on the report by Taber[44]. We undertook the Student t test to compare the distributions of each group.

Lastly, we employed the following in a multivariate analysis: HADS-D, HADS-A, and physical symptoms as dependent variables; the three perceived positive and negative growth subscales i.e. self-perception, interpersonal relationships, and philosophy of life as independent variables; and sexuality, age, years since HIV diagnosis, educational level, and annual income as control variables. We conducted a binary logistic regression analysis on the HADS-D and HADS-A scores. We undertook a Poisson regression analysis on the number of physical symptoms. We calculated an estimated index parameter value（indicated as the odds ratio in the logistic regression analysis and as the risk ratio in the Poisson regression analysis）and the 95% confidence interval（CI）. Missing values were treated by list-wise deletion. From the theoretical relationships among the scales, we conducted a hierarchical regression analysis by inserting philosophy of life in model 1, interpersonal relationships in model 2, and self-perception in model 3 sequentially.

We conducted statistical analyses packages using IBM SPSS Statistics 24 and IBM SPSS Amos 24 （Armonk, NY）.

RESULTS

The characteristics of the groups based on time since HIV diagnosis appear in **Table 1**. Only age was found to differ between the two groups（P<.001）.
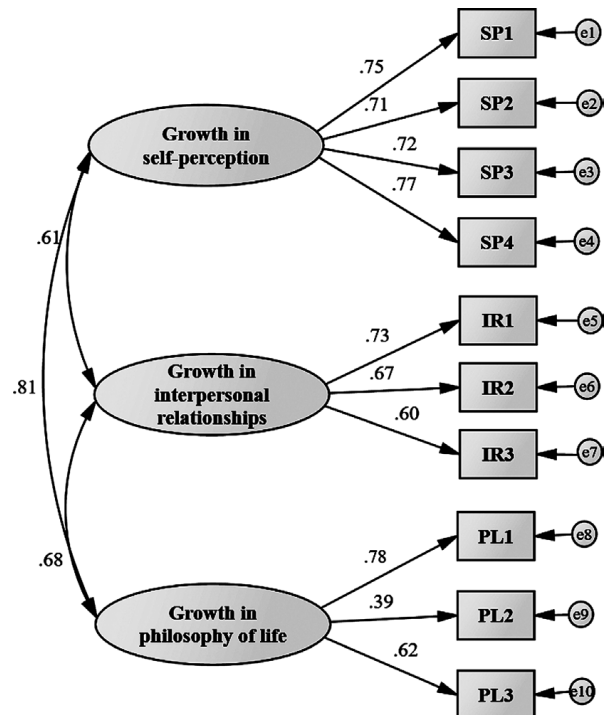

Figure 1　Final model on three-factor stress-related growth scale for Japanese people living with HIV

Table 1　Distributions about demographic characteristics by years since HIV diagnosis

| | Years since HIV diagnosis | |
| | Less than 4-year (n = 638) | 4-year or more (n = 784) |
	n　（%）	n　（%）
Sexuality		
Female	14　(2.2)	27　(3.4)
Male		
Heterosexual	18　(2.8)	18　(2.3)
Other	606　(95.0)	739　(94.3)
Education level		
Middle school/high school	222　(34.8)	272　(34.7)
Vocational school/junior college/technical college	105　(16.5)	157　(20.0)
University/graduate school	311　(48.7)	355　(45.3)
Annual income		
<1,000,000 yen	87　(13.6)	122　(15.6)
1,000,000－3,000,000 yen	207　(32.4)	230　(29.3)
3,000,000－5,000,000 yen	201　(31.5)	236　(30.1)
5,000,000－8,000,000 yen	106　(16.6)	118　(15.1)
8,000,000 yen or more	26　(4.1)	60　(7.7)
Missing	11　(1.7)	18　(2.3)
HADS-D		
depression	177　(27.8)	210　(26.9)
HADS-A		
anxiety	232　(36.4)	241　(30.8)[†]
Age		
mean　(SD)	35.8　(8.1)	40.5　(7.8)
Number of Symptoms		
median　(Q$_1$, Q$_3$)	3　(1, 6)	2　(0, 5)

[†]p = .026 in χ^2 test

HADS: Hospilal anxiety and depression scale

Table 2　Multiple group confirmatory factor analysis with less than and more than 4 years since HIV diagnosis for three-factor stress related growth scale

Model	χ^2	df	TLI	CFI	RMSEA
Model 1	362.60	64	0.89	0.94	0.057
Model 2	384.61	77	0.91	0.94	0.053
Model 3	430.08	87	0.91	0.93	0.053

Model 1 unfixed model

Model 2 equality constraints on the covariance and path coefficient values of both groups

Model 3 model 2 + equality constraints on the error variance

The CFA results are presented in **Table 2.** For all the models, the fit indexes were 0.89–0.91 for TLI, 0.92–0.94 for CFI, and 0.05–0.06 for RMSEA. Based on these goodness-of-fit indicators, Model 3 in which the TLI and RMSEA were low, and the measurement model including the measurement error variance was equal in both groups, was adopted. The standardized path coefficient and correlation coefficients appear in **Figure 1.** The psychological scale characteristics of the three perceived positive and negative growth subscales are displayed in **Table 3.** The mean values for self-perception and interpersonal relationships were negative; it was evident that a considerable

number of respondents experienced negative growth. The two groups exhibited a significant difference（P ＜.001）in the mean scores for self-perception; however, we did not observe such a difference for philosophy of life and interpersonal relationships.

The results of the logistic regression analysis about the impact of perceived positive and negative growth scale on HADS-D appear in **Table 4.** In the group with less than 4 years since HIV diagnosis, philosophy of life and interpersonal relationships had no direct effect on depression; only self-perception had a direct effect. In the final model, the positive growth in self-perception had an inhibitory association with the risk

Table 3 Psychometric properties in sub-scales of stress related growth scale

| | | | | Years since HIV diagnosis | | |
| | | | | Less than 4-year | 4-year or more | |
	Item N	Range	α	mean (SD)	mean (SD)	p
Growth in self-perception	4	−2 to 2	.831	−0.35 (0.86)	−0.07 (0.93)	<.001
Growth in interpersonal relationships	3	−2 to 2	.690	−0.05 (0.75)	−0.02 (0.79)	.594
Growth in philosophy of life	3	−2 to 2	.620	0.36 (0.80)	0.41 (0.82)	.291

a considerable number of respondents experienced negative growth. The two groups exhibited a significant difference (P<.001) in the mean scores for self-perception; however, we did not observe such a difference for philosophy of life and interpersonal relationships.

Table 4 Logistic regression analysis of the associations between growth sub-scales and depression

| | Bivariate | | | Model 1 | | | Model 2 | | | Model 3 | | |
| | OR | 95% CI | | OR | 95% CI | | OR | 95% CI | | OR | 95% CI | |
		[lower,	upper]		[lower,	upper]		[lower,	upper]		[lower,	upper]
Years since HIV diagnosi												
Less than 4-year												
'philosophy of life'	.44	[.34,	.56]	.44	[.34,	.56]	.54	[.41,	.71]	.77	[.58,	1.04]
'interpersonal relationships'	.42	[.33,	.55]				.59	[.44,	.79]	.75	[.55,	1.01]
'self-perception'	.33	[.26,	.42]							.40	[.30,	.53]
−2log likelihood				666.59			653.68			613.51		
Nagelkerke R²				.14			.17			.25		
4-year or more												
'philosophy of life'	.40	[.32,	.49]	.39	[.31,	.49]	.50	[.39,	.64]	.73	[.55,	.96]
'interpersonal relationships'	.41	[.32,	.51]				.55	[.42,	.71]	.71	[.54,	.94]
'self-perception'	.30	[.24,	.38]							.40	[.31,	.53]
−2log likelihood				810.83			788.57			737.76		
Nagelkerke R²				.16			.19			.27		

OR: odds ratio

Model 1–3 were adjusted for sexuality, age, education and annual income.

of depression. Further, in both groups, the odds ratios for philosophy of life and interpersonal relationships decreased between models 1 and 3.

The results of the logistic regression analysis about the impact of perceived positive and negative growth scale on HADS-A scores are presented in **Table 5.** In the group with less than 3 years since HIV diagnosis, philosophy of life and interpersonal relationships did not have a direct effect on anxiety scores; only self-perception had an effect. In the final model, the odds ratio (with 95% CI) for self-perception was .44 (.40 to .57); positive growth in self-perception had an inhibitory association with the risk of anxiety disorder. In both groups from models 1 to 3, we observed a decrease in the effect size of philosophy of life.

The results of the Poisson regression analysis regarding the impact of perceived positive and negative growth scale on the number of physical symptoms appear in **Table 6.** Philosophy of life had no

direct effect in the group with less than 3 years since HIV diagnosis; both self-perception and interpersonal relationships had significant effects. In model 3, regarding risk ratio (95% CI), with self-perception at .73 (.69 to .77), positive changes led to a reduction in the number of symptoms; however, with interpersonal relationships at 1.12 (1.05 to 1.19), positive changes produced an increase in the number of symptoms. Further, in the group with more than 3 years since HIV diagnosis, the three subscales had a significant effect in model 3. Specifically, in model 3, regarding risk ratio (95% CI) with philosophy of life at 1.16 (1.10 to 1.23), positive changes led to an increase in the number symptoms; however, with self-perception at .75 (.72 to .79) and interpersonal relationships at .82 (.78 to .87), positive growth led to a decrease in the number of symptoms. From models 1 to 3, the effect size of philosophy of life decreased and reversed.

Table 5 Logistic regression analysis of the associations between growth sub-scales and anxiety

	Bivariate			Model 1			Model 2			Model 3		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
		[lower,	upper]		[lower,	upper]		[lower,	upper]		[lower,	upper]
Years since HIV diagnosis												
Less than 4-year												
'philosophy of life'	.67	[.54,	.82]	.70	[.57,	.86]	.84	[.66,	1.07]	1.17	[.90,	1.53]
'interpersonal relationships'	.59	[.47,	.75]				.66	[.51,	.86]	.82	[.62,	1.08]
'self-perception'	.45	[.37,	.56]							.44	[.40,	.57]
−2log likelihood				787.12			777.22			735.96		
Nagelkerke R^2				.06			.08			.16		
4-year or more												
'philosophy of life'	.57	[.47,	.69]	.59	[.48,	.71]	.76	[.61,	.94]	.98	[.76,	1.26]
'interpersonal relationships'	.50	[.40,	.61]				.54	[.43,	.69]	.64	[.50,	.82]
'self-perception'	.49	[.41,	.59]							.58	[.46,	.74]
−2log likelihood				905.48			878.72			856.88		
Nagelkerke R^2				.09			.13			.17		

OR: odds ratio

Model 1–3 were adjusted for sexuality, age, education and annual income.

Table 6 Poisson regression analysis of the associations between growth sub-scales and number of symptoms

	Bivariate			Model 1			Model 2			Model 3		
	RR	95% CI		RR	95% CI		RR	95% CI		RR	95% CI	
		[lower,	upper]		[lower,	upper]		[lower,	upper]		[lower,	upper]
Years since HIV diagnosis												
Less than 4-year												
'philosophy of life'	.88	[.84,	.93]	.91	[.86,	.95]	.90	[.85,	.95]	1.02	[.96,	1.09]
'interpersonal relationships'	.93	[.88,	.98]				1.02	[.96,	1.08]	1.12	[1.05,	1.19]
'self-perception'	.76	[.73,	.80]							.73	[.69,	.77]
AIC				3862.29			3826.86			3708.93		
4-year or more												
'philosophy of life'	.87	[.83,	.91]	.88	[.85,	.92]	1.01	[.96,	1.07]	1.16	[1.10,	1.23]
'interpersonal relationships'	.74	[.71,	.78]				.75	[.71,	.79]	.82	[.78,	.87]
'self-perception'	.74	[.71,	.77]							.75	[.72,	.79]
AIC				5210.57			5067.96			3709.17		

RR: risk ratio

Model 1–3 were adjusted for sexuality, age, education and annual income.

DISCUSSION

Factor structure and subscales of SRG

In the present study, we verified that the perceived positive and negative growth scale comprised three factors[16]. Further, we confirmed that the factor structure was a metric invariance model that was not based on the number of years since HIV diagnosis.

With regard to the mean score of the subscales, those of self-perception and interpersonal relationships were negative. Similar scales assessing PTG-inventory or SRG-scale in previous studies demonstrated one factor[13, 45], three factors[46], and five factors[16], and only positive changes[13, 16, 45, 46]. We confirmed the model of a three-factor structure with factors similar to the prior theory[16] and the scale by Yucetin et al.[46]. The index used in the present investigation also showed negative changes; thus, it can be said that it depicts changes in cognitive beliefs more accurately than those used in previous reports. Additionally, the present results suggest that the event of receiving the HIV diagnosis and subsequent stressful experiences (such as self-management of

the illness and stigmatization) caused negative cognitive changes; those changes may have occurred in approximately half of our participants.

Mechanism of association between mental health and SRG

Regarding the association between mental health and SRG, as suggested in previous studies and review papers[21, 23, 29, 30, 33], we observed a negative association between the subscales of our SRG scale and mental health. Further, with respect to the association with mental health based on correlation between the subscales, the mechanism was different between the group with less than 4 years since HIV diagnosis and that with over 4 years. In the group with less than 4 years since HIV diagnosis, self-perception had a direct effect on both depression and anxiety disorder; philosophy of life and interpersonal relationships exerted only an indirect effect, which was mediated by self-perception. In the group with over 4 years since HIV diagnosis, self-perception and interpersonal relationships were independently associated with maintaining and improving mental health. The mediating effects of self-perception were not sufficiently observed and this was not clarified in previous studies. The reasons why the qualitative relationship between stress-related growth and mental health varies depending on the number of years since HIV diagnosis, and in particular, why the effects of self-perception change, remain unknown and are research challenges for a future study.

Mechanism of association between number of physical symptoms and SRG

Few previous studies examined the association between physical health and SRG; a positive relationship was noted with good physical health in two studies[33, 46]; however, the present investigation suggests the possibility of a strong association. It is clear that as in the case of mental health, this association has mechanisms and effects that differ significantly depending on the number of years since HIV diagnosis. In the group with less than 4 years since diagnosis, positive growth in self-perception was associated with reduced symptoms; however, it was also apparent that positive changes in interpersonal relationships were associated with increased symptoms. Even with newly diagnosed HIV, a stronger the illness perception leads to higher growth[47]. Therefore, people with more symptoms may have grown by seeking and building relationships.

Theoretical and practical suggestions

This study has produced the following two theoretical suggestions. First, regarding changes in respondents 'perceptions of themselves and their world, owing to chronic and acute stresses (such as negative events and illnesses), it would be more precise to measure both positive (such as growth and discovery of benefits) and negative aspects.

Second, this study found that though it is possible to measure SRG after a traumatic event regardless of the length of elapsed time, functions related to health differ greatly depending on the duration. Further, mental and physical health as well as the functions that act on them differ greatly depending on the SRG subscale. Not all elements of SRG have a positive influence on health. Further clarification of the health maintenance / promotion function and its mechanism using the subscales of this growth scale is required.

The present study also led to the following two practical suggestions. First, when consulting with PLWH, it is important to have a high SRG scale score in order to encourage positive changes in thinking about life to lead to growth. Furthermore, it is necessary to develop individual and collective intervention programs to promote such cognitive changes based on the three factors that were confirmed in this study. Moreover, particularly among PLWH with over 4 years since diagnosis, diverse educational programs and opportunities to take courses would be useful in facilitating adaptation to self-management and to produce changes in perceptions of themselves and others.

Second, it is possible that the perceived positive and negative growth scale could be applied as a self-management tool for PLWH. In this regard, it will be necessary also to consider developing intervention policies to promote positive cognitive change.

Limitations and future studies

The methodological strength of this study was the adoption of the participatory approach. This affected the practical suitability of this study and the accuracy of recruiting research participants[37]. As such, this study was able to clarify the structure of the SRG factors in Japanese PLWH, in addition to the mechanism underlying the associations among factors that affect mental health and physical symptoms. However, this study has a number of limitations.

First, regarding web-based open research, participants in this study were limited to PLWH who received survey guidance, and it is possible that our sample was restricted to skilled users of computers and mobile terminals. Specifically, with our sample,

the age range was lower than that of participants surveyed through medical institutions and a shorter time had passed since HIV diagnosis. In Japan, there is no PLWH registration system and it is not possible to conduct a representative sampling survey on prevalence. The overall picture of Japanese PLWH has yet to emerge: it may not be that there was participant bias in our study or that the participant sample in the previous survey（contacted through medical institutions）was representative. However, in future, it will be necessary to confirm the reproducibility of our results among older participants who may have difficulty in accessing an Internet-based survey.

Second, the reliability of the perceived positive and negative growth scale used in this study has yet to be fully determined. Subscales had low Cronbach's $α$ coefficients and did not demonstrate satisfactory internal consistency. Thus, it is difficult to clinically apply each subscale such as during screening. While investigating the reproducibility in other samples, it will be necessary to investigate the intraclass correlation and stability.

The final limitation was that this study had a cross-sectional design. A follow-up study is required to assess causality and predictive validity. At the same time, it is also a future research subject to examine the causal relationship not only with perceived health but also with objective health. Furthermore, the possibility of using this growth scale as an assessment tool or screening tool for life adaptation should be investigated.

CONCLUSIONS

This nationwide survey of Japanese people living with HIV using a cross-sectional design clarified the following three points regarding SRG resulting from HIV diagnosis.

1. SRG comprises three factors: self-perception, interpersonal relationships, and philosophy of life. The factor structure and measurement of these subscales remained constant irrespective of the number of years since HIV diagnosis.
2. The mechanism of the association between the scales and mental health changed depending on whether more or less than 4 years had passed since HIV diagnosis. In the group with over 4

Appendix　Stress-related growth scale for Japanese people living with HIV（in Japanese）

Item	Negative pole（−2）	Positive pole（＋2）
Ever since you found out you were HIV positive,（HIV陽性がわかってから今までに、）		
Self-perception（自己認知）		
SP2　I have become mentally…（精神的に、）	weak（弱くなった）	strong（強くなった）
SP1　my confidence to get through life（人生を乗り越えていく自信は）	decreased（減った）	increased（増えた）
SP3　purpose in life and enjoyment of life were（生きがいや人生の楽しみは）	have been lost（失われた）	obtained（得られた）
SP4　for anything（何事に対しても）	I started thinking in the wrong direction（悪い方向に考えるようになった）	I started thinking in the right direction（良い方向に考えるようになった）
Interpersonal relationships（対人関係）		
IR3　relationships and ties with partners/partners or family members（交際相手・パートナー、あるいは家族との関係・絆は）	have weaken（弱くなった）	have become stronger（強くなった）
IR1　relations and bonds with friends（友人との関係・絆は）	have weaken（弱くなった）	have become stronger（強くなった）
IR2　the number of trusted friends and acquaintances（信頼できる友人や知人は）	has decreased（減った）	has increased（増えた）
Philosophy of life（生の哲学）		
PL1　for going day by day,（一日一日を過ごしていくことに対して）	I didn't care.（どうでもよくなった）	I feel important.（大切に感じるようになった）
PL2　in my life, to my health,（生活の中で、健康に対して）	I have come not to pay attention（注意を払わなくなった）	I have come to pay attention（注意を払うようになった）
PL3　my desire to be useful to people and society（人や社会のために役に立ちたいという思いは）	has weakened（弱くなった）	has grown stronger（強くなった）

All items are on a 5-point Likert scale, "0" was set to "no change（変化なし）".

years since diagnosis, multivariate analysis simultaneously including all the scales showed an independent positive effect. With the multivariate analysis that also included the group with less than 4 years since diagnosis, such an association was found only for self-perception.

3. The physical symptoms of each scale and the association mechanisms differed according to the time since HIV diagnosis. Multivariate analysis showed that in the group with over 4 years since diagnosis, positive growth in interpersonal relationships and self-perception led to a reduction in physical symptoms; however, philosophy of life was linked to increased physical symptoms. When the group with less than 4 years since diagnosis was included, no association with philosophy of life was found; however, positive growth in self-perception led to reduced physical symptoms, and positive growth in interpersonal relationships led to better physical health.

Ethics approval and consent to participate

Competing interests

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