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Associations of Well-Being With Psychological and Socioeconomic Status After the Fukushima Nuclear Disaster

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Original Research

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Abstract

Objective: This study exploratively analyzed the associations of well-being with psychological characteristics, socioeconomic status (SES), and the number of relocations after the Fukushima nuclear disaster.

Methods: Using a cross-sectional study design, an online questionnaire survey was administered to 416 residents of Fukushima and Tokyo each aged 20-59 years (832 in total) between August 25 and 26, 2018, which was 7 and a half years after the disaster. Categorical factor analysis and multiple regression analysis were performed to investigate associations of 5 well-being scales (positive emotion, negative-free emotion, life satisfaction and general happiness, positive characteristics, and positive functioning) with psychological characteristics, SES, and the number of relocations.

Results: Four of the well-being scales, except for negative-free emotion, were strongly associated with each other and showed similarities in the strength of their associations with psychological characteristics and SES. Among the items surveyed, psychological distress, mindfulness, and marital status were strongly associated with well-being among Fukushima residents. Contrarily, radiation risk perception or the number of relocations were not significantly associated with well-being.

Conclusions: Focusing on psychological distress is expected to have a significant impact on improving well-being after the disaster. In addition, assistance in avoiding unintended family separation may be helpful.

Achieving well-being is one of the goals of humanity. This is a particularly challenging issue after a disaster, as exposure to disasters has been reported to reduce well-being in recent years. People's well-being declined after the coronavirus disease 2019 pandemic.[1,2] The Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Station accident (hereinafter, Fukushima disaster) in March 2011 has been observed to reduce well-being among the affected people.[3,4] Murakami et al. found that 7 years after the Fukushima disaster, well-being was lower among evacuees who had not yet decided whether or not to return to their hometowns.[5] The World Health Organization (WHO) and the United Nations have emphasized the importance of promoting well-being and providing psychological support after disasters.[6,7] This perspective by international organizations is in line with that of front-line communicators who have regarded the restoration of affected people' well-being as a top objective of their activities after the Fukushima disaster.[8]

In order to promote policies and interventions that improve well-being, it is important to identify the factors associated with it. A variety of fields, including economics, public health, environmental studies, and psychology, have been advanced to identify factors that affect people's well-being and to develop programs to improve it.[13-20] In particular, well-being is strongly related to psychological characteristics and socioeconomic status (SES), including income, educational background, employment status, and marital status, highlighting the importance of policies to improve well-being according to the target population.[21-23] The same is true in the event of a disaster. Given that psychological distress was strongly associated with lower well-being among evacuees amid the Fukushima disaster[5] and that their psychological distress was affected by mindfulness, health anxiety, and radiation risk perception,[24] understanding how these psychological characteristics affect well-being is useful in examining the post-disaster support. Furthermore, SES of those affected by disasters changes in line with policies such as long-term evacuation and lockdown implemented by large-scale disasters. In the Fukushima

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disaster, people experienced lower annual incomes, unemployment, and separation from their families as a result of forced or voluntary evacuation.[25,26] Given that SES is associated with well-being in normal times, as discussed above, it is important to assess well-being in the aftermath of a disaster, in terms of both psychological characteristics and SES.

Previous studies have shown that disasters have unequal health effects including psychological distress on populations with different SES.[27-31] The United Nations also emphasizes policies that address SES after disasters.[32] An understanding of the associations of well-being with psychological characteristics and SES provides a foundation for post-disaster public policy, such as identifying populations that need support to promote well-being and determining the allocation of psychological support resources to them. However, while some studies have discussed the decline in well-being after a disaster, focusing on evacuation status and health status,[5,33] limited research studies have comprehensively addressed what psychological characteristics and SES were strongly associated with well-being.

Therefore, this study investigated the associations of well-being with psychological characteristics and SES in an exploratory manner to identify populations in need of support in promoting well-being after disasters and to understand effective support. In addition to psychological distress, which showed a marked increase after disasters, the psychological characteristics included the radiation risk perception, which is unique to nuclear disasters.[34] This study also investigated whether the number of relocations after the disaster had an adverse impact on well-being, because frequent relocations had a serious impact on psychological distress among people affected by the Fukushima disaster.[35]

Methods

Ethics

Ethical approval for this study was obtained from the ethics committee of Fukushima Medical University (approval number: General 30016). Respondent consent was obtained before the survey. The survey results were collected anonymously from participants. The participants received compensations in the form of points redeemable for products from the company conducting the survey.

Study Design and Participants

This study was performed in a cross-sectional study design. An online survey was conducted between August 25 and 26, 2018. The survey was mainly conducted to analyze associations of psychological distress with mindfulness, health anxiety, and radiation risk perception. In addition, the associations of radiation risk perception with scientific knowledge and residential locations were also analyzed. Studies using this survey have been previously reported.[24,36] Since then, many studies have accumulated findings that the health effects of disasters differ depending on SES,[27-31] and the importance of considering SES in supporting people affected by disasters has gained international recognition,[32] as described in "Introduction." Therefore, this study was conducted with the aim of exploring SES and psychological characteristics that were strongly associated with well-being, which is different from these previous studies.[24,36] However, in consideration of the previous finding that frequent relocation after the Fukushima disaster has an impact on mental health,[35] the number of relocations was also added as a factor to investigate the associations with well-being.

Details of the questionnaire survey were reported in a previous study.[24] Briefly, the survey was conducted among individuals aged 20-59 living in Fukushima Prefecture and Tokyo Metropolis. Tokyo was chosen as a control site to evaluate differences from Fukushima residents who were strongly affected by the Fukushima disaster. The survey was conducted among registered monitors of Macromill, Inc. The target number of respondents was set at approximately 800 (400 each in Fukushima and Tokyo), and responses were solicited until the target number was achieved. As a result, a total of 832 participants (416 each in Fukushima and Tokyo) responded. The participants were collected so that their gender and age ratio would be in line with the demographic composition of each prefecture. Considering the population of Tokyo and Fukushima, the 95% confidence interval and the 5% margin of error required sample size was 384 for each.[37] The sample size for this study exceeded this value.

The reason for targeting residents of Fukushima Prefecture as a whole in this study was that deterioration in mental health following the Fukushima disaster was observed not only among evacuees but also among residents hosting them,[38] as well as among females and people aged 40 and over throughout Fukushima Prefecture, including the Nakadori area (central region) and the Aizu area (mountain-side region).[39] The previous study reported that the proportion of high radiation risk perception regarding genetic effects was significantly lower among these participants in Fukushima Prefecture (54.6%) than Tokyo participants (61.3%) and that the difference was explained by the differences in their knowledge of the genetic effects.[36] The value among the Fukushima participants in this study was higher than that among evacuees in a survey conducted in the same year by Fukushima Health Management Survey (37.2%),[34] indicating that the participant group in this study was more aware of the risk of radiation exposure.

Questionnaire Items

Well-being

While the definition and scales of well-being vary among academic fields or organizations,[9,10] Nettle classified well-being into 3 categories: momentary feelings of emotion, judgements about feelings over the long-term, and quality of life that satisfies one's potential (i.e., psychological well-being).[11] Graham et al. also provided insights into policy based on a similar classification.[12] Therefore, this study examined well-being according to these 3 categories. Momentary feeling of emotion and psychological well-being were each further grouped into 2 scales, for a total of 5 scales. The reliability and stability of these 5 scales was demonstrated in previous studies.[5,40] The details of the questionnaire and the options are also previously described.[5]

- Momentary feeling of emotion

This category consisted of 6 items designed according to the previous study.[22] The experience of joy, happiness, and laughter on the previous day was classified as "positive emotion," and the lack of experience of stress, sadness, and anxiety (reversal items for each) as "negative-free emotion." The 2 subscales are based on differences in the nature of positive and negative emotions.[41-45]

- Judgements about feelings over the long-term

Judgements about feelings over the long-term were measured in terms of life satisfaction[13] and general happiness.[46]

- Psychological well-being

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This category consisted of 9 items, divided into 2 scales: "positive characteristics" (vitality, emotional stability, optimism, resilience, and self-esteem) and "positive functioning" (engagement, meaning, positive relationships, and competence).[46]

Psychological characteristics

The details of these questions are described in a previous study.[24]

Psychological distress was measured by the Japanese version of the Kessler-6-Scale (K6), which evaluates the degree of nonspecific psychological mood such as depression and anxiety over the past 30 days, using a total score of 6 items.[47,48]

Dispositional mindfulness was measured using the Japanese version of the Five Facet Mindfulness Questionnaire (FFMQ).[49,50] The FFMQ consists of a total of 39 items, which were evaluated based on the total score.

Health anxiety was measured with the Japanese version of the Health Anxiety Scale (HAI-J),[51] which was based on the Short Health Anxiety Inventory (SHAI).[52] The HAI-J consists of 10 questions about health anxiety over the past 6 months and 4 items about feelings of being seriously ill. The average score of 14 items was used.

The perception of genetic risk due to radiation exposure (radiation risk perception) consists of a single item that asks the likelihood to which current radiation exposure will cause health effects in the next or future generations.[26,53] At this time, respondents in Tokyo were asked about the likelihood of possible health effects on people in Fukushima Prefecture.[54]

Socioeconomic status (SES)

Participants were asked to answer about SES including employment status, marital status, educational background, and annual household income. The classification of the options was similar to that previously reported.[24]

Employment status was classified into 3 groups: "employee etc.," "self-employed etc.," and "other." The breakdown of each was as follows: "employee etc." were company employees, civil servants, non-profit-organization employees, teachers, health professionals, or other professionals; "self-employed etc." was agriculture, forestry, and fishery workers and other self-employed workers; "other" included part-time or casual workers, working on the side, housewife/husband, university students, technical college students, junior college students, preparatory school students, jobless, retired, and other.

Marital status was classified into 2 groups: "married (living together)" and "unmarried and separation." The unmarried and separation included the following 4 options: unmarried, married (living separately), divorced, and bereaved.

Educational background was categorized into 2 groups: "junior or high school graduate" and "university etc. graduate" The latter included professional training graduate, junior college graduate, technical college graduate, 4-year university graduate, 6-year university graduate, and completion of graduate school.

Household annual income was categorized into 4 groups: "< 3 million yen," "3-6 million yen," "≥ 6 million yen," and "do not answer."

Other individual attributes

The potential covariates used in this study were gender, age (20s, 30s, 40s, and 50s), hypertension history, mental illness history, and the number of relocations since the Fukushima disaster. The associations of well-being with gender, age, and hypertension history have been reported previously among the people affected by the Fukushima disaster.[5] Considering that depression and well-being are negatively correlated,[55] mental illness history was addressed. The number of relocations was asked, given that the experience of relocations after the Fukushima disaster was related to psychological distress[35] and that evacuation status was related to well-being.[5] The number of relocations was classified into 2 groups, 3 or less times and 4 or more times, according to the previous study.[35]

The SES and other individual attributes are shown in Table 1. The participants with frequent relocations after the disaster (≥ 4) were 2.6% for Fukushima and 3.6% for Tokyo.

Statistical Analysis

First, as in the previous study,[5] categorical factor analysis was conducted to structure 5 types of well-being (positive emotion, negative-free emotion, life satisfaction and general happiness, positive characteristics, and positive functioning). The comparative fit index (CFI) ≥ 0.90, root mean square error of approximation (RMSEA) < 0.08, and standardized root mean squared residual (SRMR) < 0.08 were used as indicators of the acceptable fit for the factor model.[56]

For psychological characteristics, the sum or arithmetic mean of all items was used as a continuous quantity. Cronbach's alpha coefficient, which represents internal consistency of the variables used in this study, was 0.892 for K6, 0.786 for FFMQ, and 0.868 for HAI-J, exhibiting that the calculation of sum or mean was deemed appropriate.

The associations between well-being and psychological characteristics were tested using Pearson's *r*. The associations of well-being with SES and other individual attributes were analyzed using t-tests for items with 2 groups and analysis of variance for items with 3 or more groups.

Multiple regression analyses were then conducted with each well-being as the objective variable and the psychological characteristics, SES, and other individual attribute items that were significantly associated with well-being in univariate analyses as explanatory variables. However, the number of relocations was also added as an explanatory variable in the multiple regression analysis, although it was not significant in the univariate analysis. Similar multiple regression analyses were performed stratified by location of participants (Fukushima and Tokyo).

All variance inflation factors (VIFs) were ≤ 2.76, indicating low multicollinearity. IBM SPSS Versions 25 and 30, R,[57] and R packages[58,59] were used for analysis. A significance level was set at 5%.

Results

Categorical Factor Analysis of Well-being

Responses to each well-being item are shown for all participants, Fukushima, and Tokyo residents (Table 2). The proportion and median values were shown for 6 items comprising positive emotion and negative-free emotion, and for 11 items comprising life satisfaction and general happiness, positive characteristics, and positive functioning, respectively. Figure 1 shows the results of a model of 5 types of well-being using categorical factor analysis. The goodness of fit of the model was 0.970 for CFI, 0.084 for RMSEA, and 0.061 for SRMR. The reliability coefficients (ω and α) were as follows: positive emotion, ω = 0.852 and α = 0.909; negative-free emotion, ω = 0.693 and α = 0.859; life satisfaction and general happiness, ω = 0.937 and α = 0.944; positive characteristic, ω = 0.727 and α = 0.736; positive functioning, ω = 0.720 and α = 0.743. The standard estimates

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Table 1. Socioeconomic status and other individual attributes. Data except the number of relocations and hypertension history were reported in a previous study[24]

		N (%)		
		All participants	Fukushima	Tokyo
Gender	Men	427 (51.3)	215 (51.7)	212 (51.0)
	Women	405 (48.7)	201 (48.3)	204 (49.0)
Age	20s	169 (20.3)	78 (18.8)	91 (21.9)
	30s	214 (25.7)	102 (24.5)	112 (26.9)
	40s	236 (28.4)	114 (27.4)	122 (29.3)
	50s	213 (25.6)	122 (29.3)	91 (21.9)
Hypertension history	No	732 (88.0)	357 (85.8)	375 (90.1)
	Yes	100 (12.0)	59 (14.2)	41 (9.9)
Mental illness history	No	761 (91.5)	381 (91.6)	380 (91.3)
	Yes	71 (8.5)	35 (8.4)	36 (8.7)
Number of relocations	≤ 3	806 (96.9)	405 (97.4)	401 (96.4)
	≥ 4	26 (3.1)	11 (2.6)	15 (3.6)
Job	Employee etc.	465 (55.9)	212 (51.0)	253 (60.8)
	Self-employed etc.	48 (5.8)	27 (6.5)	21 (5.0)
	Other	319 (38.3)	177 (42.5)	142 (34.1)
Marital status	Married (living together)	436 (52.4)	239 (57.5)	197 (47.4)
	Unmarried and separation	396 (47.6)	177 (42.5)	219 (52.6)
Educational background	Junior or high school graduate	255 (30.6)	185 (44.5)	70 (16.8)
	University etc. graduate	577 (69.4)	231 (55.5)	346 (83.2)
Annual household income	< 3 million yen	155 (18.6)	91 (21.9)	64 (15.4)
	3–6 million yen	252 (30.3)	129 (31.0)	123 (29.6)
	≥ 6 million yen	277 (33.3)	108 (26.0)	169 (40.6)
	Do not answer	148 (17.8)	88 (21.2)	60 (14.4)

for well-being from each item were all high, confirming the reliability of this model. Correlations among the 5 well-being items were strong except for negative-free emotion.

Associations of Well-being With Psychological Characteristics, Socioeconomic Status (SES), and Number of Relocations

The associations of well-being with psychological characteristics and with SES and other individual attributes are shown in Tables S1 and S2, respectively. Overall, psychological distress, health anxiety, and radiation risk perception were significantly and negatively associated with well-being, while mindfulness showed significant and positive associations with well-being. Among SES and other individual attributes, the number of relocations and hypertension history were not significantly associated with any dimensions of well-being.

Standardized partial regression coefficients (β) were compared across items for all participants to evaluate the strength of the associations of well-being with psychological characteristics, SES, and the number of relocations (Figure 2 [a-e] and Table S3). Psychological distress had the strongest significant negative association with any of the 5 well-being scales. The next strongest association among the psychological characteristics was mindfulness, which had a significant positive association with any of the well-being scales except negative-free emotion. Health anxiety had a small but significant negative association only with negative-free emotion. Radiation risk perception was not significantly associated with any of well-being.

Marital status had the strongest association with well-being among the SES. Unmarried or separation was significantly and negatively associated with all 3 well-being scales, except for negative-free emotion and positive characteristics. Increasing annual household income also showed a significant positive association with any of the 4 well-being scales except negative-free emotion. Similarly, educational background showed significant positive associations with all 4 well-being scales except negative-free emotion, but the strength of the associations between educational background and well-being was smaller than that between annual household income and well-being. Employment status and the number of relocations was not significantly associated with any of the well-being scales.

Figure 2 (f-j, k-o) and Tables S4-5 show the results of the stratified analysis, dividing the participants into Fukushima and Tokyo residents. The results were generally similar to those for all participants, but some differences existed between Fukushima and Tokyo in terms of health anxiety, annual household income, educational background, and marital status. Health anxiety was significantly and negatively associated with negative-free emotion

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Table 2. Crude results of well-being

	All participants	Fukushima	Tokyo
Enjoyment[a]	57.3% (54.0%–60.7%)	55.5% (50.8%–60.3%)	59.1% (54.4%–63.9%)
Emotional happiness[a]	57.6% (54.2%–60.9%)	57.0% (52.2%–61.7%)	58.2% (53.4%–62.9%)
Laughter[a]	83.3% (80.8%–85.8%)	83.7% (80.1%–87.2%)	82.9% (79.3%–86.5%)
Stress-free[b]	24.2% (21.3%–27.1%)	21.2% (17.2%–25.1%)	27.2% (22.9%–31.4%)
Sadness-free[b]	69.1% (66.0%–72.3%)	69.0% (64.5%–73.4%)	69.2% (64.8%–73.7%)
Worry-free[b]	40.5% (37.2%–43.8%)	40.1% (35.4%–44.9%)	40.9% (36.1%–45.6%)
Life satisfaction[c]	6 [5, 8]	6 [5, 7]	7 [5, 8]
General happiness[c]	6 [5, 8]	6 [5, 8]	7 [5, 8]
Vitality[c]	2 [2, 3]	2 [2, 2]	2 [2, 3]
Emotional stability[c]	2 [2, 3]	2 [2, 3]	2 [2, 3]
Engagement[c]	4 [3, 4]	3 [3, 4]	4 [3, 4]
Meaning[c]	3 [2, 4]	3 [2, 4]	3 [2, 4]
Optimism[c]	3 [2, 4]	3 [2, 4]	3 [2, 4]
Positive relationship[c]	4 [3, 4]	3.5 [3, 4]	4 [3, 4]
Resilience[c]	3 [2, 3]	3 [2, 3]	3 [2, 4]
Self-esteem[c]	3 [2, 4]	3 [2, 4]	3 [2, 4]
Competence[c]	3 [2, 3]	3 [2, 3]	3 [2, 4]

[a]Percentage of respondents who answered "Yes" to the questionnaire. Numbers in parentheses indicate 95% confidence intervals.
[b]Percentage of respondents who answered "No" to the questionnaire. Numbers in parentheses indicate 95% confidence intervals.
[c]Median [first quartile, third quartile].

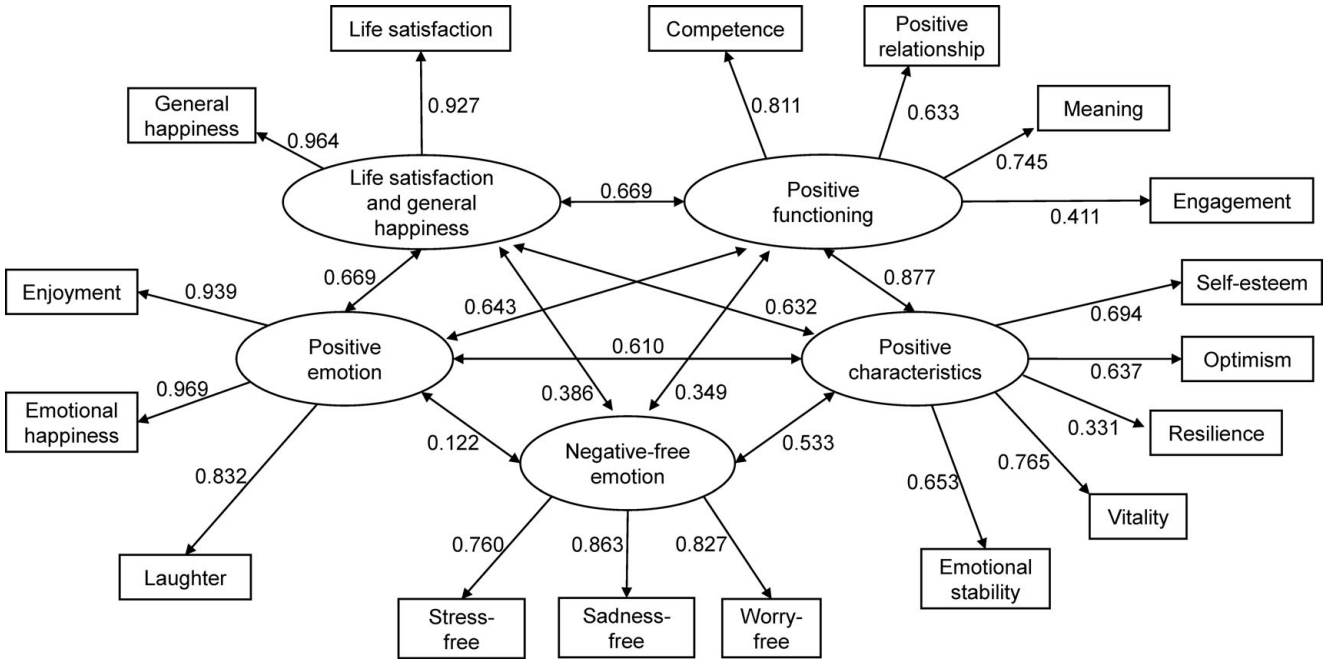

Figure 1. Standardized estimates from categorical factor analysis for well-being. Comparative fit index: 0.970; root mean square error of approximation: 0.084; standardized root mean square residual: 0.061.

in Fukushima but not in Tokyo. In Fukushima, no significant differences were observed in well-being except positive functioning among annual household income. Contrarily, Fukushima showed a significant negative association between marital status and the 4 well-being scales except negative-free emotion, whereas in Tokyo, marital status was associated with only 2 well-being scales (i.e., positive emotion, life satisfaction and general happiness). For marital status, the absolute value of β was generally larger in Fukushima than in Tokyo.

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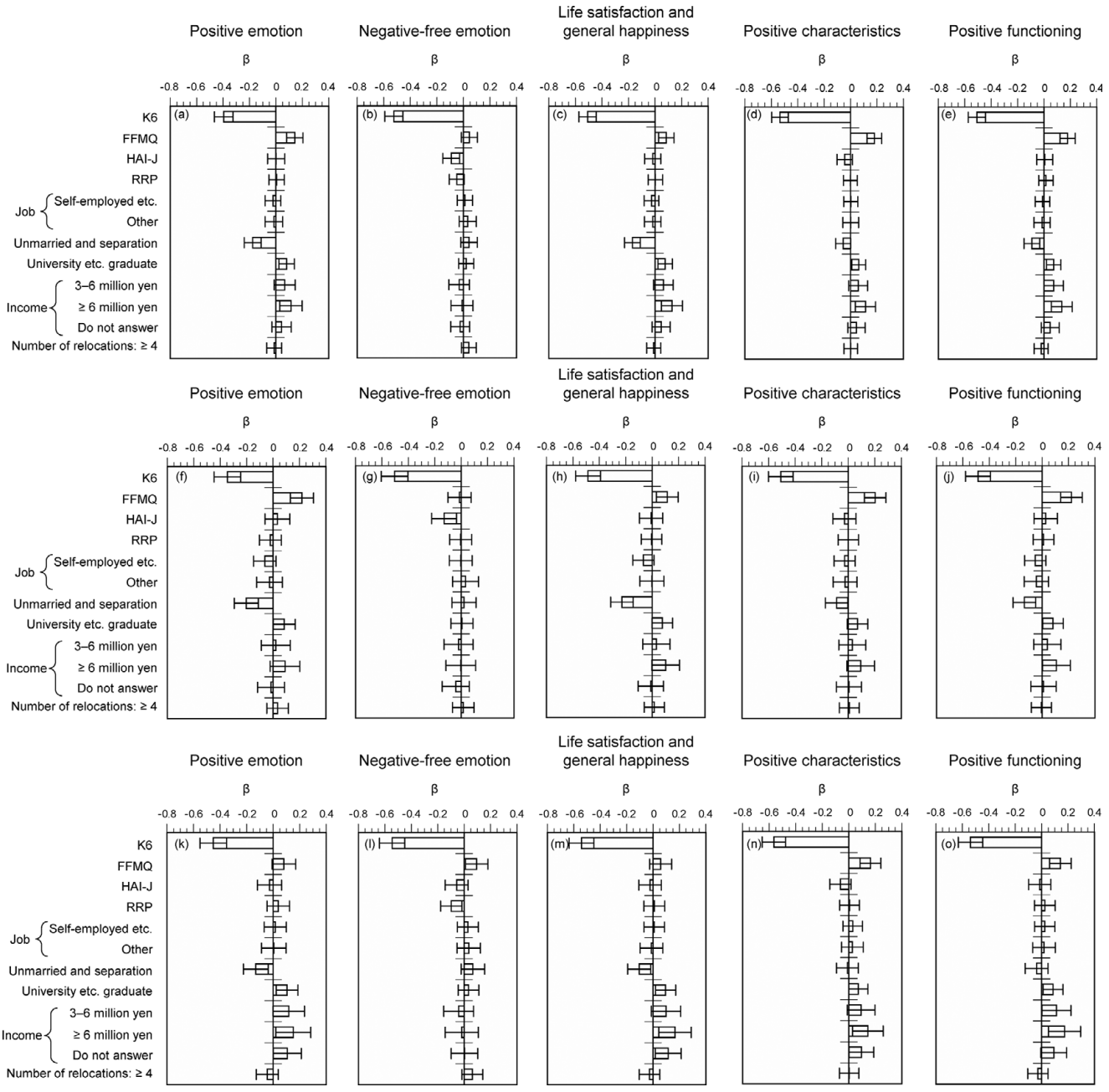

Figure 2. Associations of well-being with psychological characteristics, socio-economic status, and number of relocations. (a-e) All participants. (f-j) Fukushima residents. (k-o) Tokyo residents. Positive emotion: (a, f, k); negative-free emotion: (b, g, l); life satisfaction and general happiness: (c, h, m); positive characteristics: (d, i, n); positive functioning: (e, j, o). β: standardized partial regression coefficient. K6: Kessler-6-Scale (psychological distress); FFMQ: Five-Facet Mindfulness Questionnaire (mindfulness), HAI-J: the Japanese version of the Health Anxiety Scale (health anxiety); RRP: radiation risk perception. An error bar represents 95% confidence interval. Detailed results including covariates (gender, age, and mental illness history) are shown in Tables S3-5.

Discussion

This study analyzed the associations of well-being with psychological characteristics, SES, and number of relocations among Fukushima and Tokyo residents approximately 7 and a half years after the Fukushima disaster.

Similarities and Differences Among Five Types of Well-being

The values of each item of well-being of Fukushima residents in this study were similar or slightly higher than those in a previous study conducted on evacuees or returnees in January 2018[5] (e.g., the present study vs. previous study: emotional happiness 57.0% vs. 51.3%). The slight difference might be due to the difference that the present study targeted the 20-59 age group in the whole of Fukushima Prefecture, whereas the previous study surveyed the 20-79 age group of residents in the former evacuation order areas. Importantly, the well-being scales in the present study were well structured by categorical factor analysis, and the structure was similar to that of the previous study.[5] Interestingly, both in the present and previous studies, negative-free emotion had weak correlations with the other well-being scales. The other 4, on the

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other hand, had strong correlations with each, and generally showed similar results for their associations with psychological characteristics, SES, and number of relocations. These results provide 1 insight into what kind of well-being scales to assess. Negative-free emotion may be different in nature from other forms of well-being. Indeed, in the aftermath of the Fukushima disaster, experiencing negative emotions was positively associated with sense of resilience.[60] Hence, negative-free emotion, measured by asking about feelings yesterday, may not be an appropriate indicator of the kind of society that people should aspire to after a disaster. While well-being has been proposed and used in various academic fields including economics and psychology to describe momentary feelings of emotion, judgements about feelings over the long-term, and psychological well-being,[13,15,16,45] this study emphasizes that all 4 of these well-being scales, despite their conceptual differences, show consistent tendency. Thus, in practice, only 1 of the scales can be used to approximate well-being status, and a robust assessment of well-being status can be achieved by measuring a comprehensive set of scales.

Social Implications for Improving Well-being: A Perspective From Psychological Characteristics, Socioeconomic Status (SES), and Number of Relocations

This study exploratively examined items in the participants' psychological characteristics, SES, and number of relocations that showed strong associations with well-being. The strongest association was found to be psychological distress, which was also previously shown among those affected by the Fukushima disaster.[5] In the present study, similar findings were obtained in Fukushima and Tokyo residents, suggesting that the findings are not limited to the people affected by the disaster. The proportion of people with psychological distress increases significantly after a disaster, regardless of the type of a disaster.[61-63] When attempting to improve well-being after a disaster, the priority is likely to screen for psychological distress. Providing administrative or medical intervention for those in high psychological distress is important to alleviate their psychological distress as soon as possible.[64] Significant negative associations of psychological distress with social network connections and social network have been observed among the people affected by the Fukushima disaster.[38,65],and the significance of post-disaster administrative intervention through social networks is one of the 5 principles known as Hobfoll's 5 principles.[66]

Next to psychological distress, this study revealed that mindfulness was strongly associated with well-being. A previous study analyzing the same data as the present study has also shown that mindfulness led to improvements in psychological distress.[24] These results reiterate the usefulness of mindfulness in supporting the people affected by the Fukushima disaster. Following a nuclear disaster, individual-level psychological interventions had an effect on improving well-being.[67] Indeed, after the Fukushima disaster, an intervention improved mindfulness and self-compassion by focusing on the rich natural environment of Fukushima.[68] Importantly, among the psychological characteristics surveyed, radiation risk perception as well as health anxiety was weakly or not associated with well-being. This is consistent with the finding that, even among those who evacuated after the disaster, the radiation risk perception was much more weakly associated with well-being than psychological distress.[69] A psychological intervention program was reported to improve mental health without changing radiation risk perceptions after the disaster.[70] Therefore, while in the aftermath of the Fukushima disaster the importance of disseminating information about radiation risk has often been highlighted, addressing radiation risk perception was not likely to contribute to improving well-being, at least 7 and a half years after the disaster, at the time of this survey. Giving that improving radiation risk perception plays an important role in improving stigma and social division,[71,72] the multidimensionality required for post-disaster recovery demonstrates the limitations of discussing only the well-being scales addressed in this study.

Among SES, marital status showed the strongest association with well-being, especially in Fukushima compared to Tokyo. This result requires caution in interpretation because we combined unmarried persons with married persons separately living from their partners due to the limited number of participants; however, a previous study showed that, especially among men affected by the Fukushima disaster, both unmarried persons and married persons not living together with their partners showed a decline in well-being compared to those who were married and living together.[5] After the Fukushima disaster, some households chose to reside separately following mandatory or voluntary evacuation.[25] In addition, men and women had different opinions on whether or not to return to their hometown after the evacuation order was lifted.[73] Thus, separation from partners against their will may have led to a decline in well-being. To avoid such unintended separation, decision support based on assistance with employment and participation in new community activities is important to facilitate the adjustment of all family members, regardless of their willingness to return to their hometown.

Within the SES, annual household income was associated with well-being for all participants and Tokyo residents. This result well agreed with a previous study in Japan.[74] Contrarily, no associations were found except positive functioning among Fukushima residents. This could be attributed to the Fukushima disaster or original cultural characteristics of the Fukushima residents, unrelated to the disaster. No associations with well-being were found for employment status in either Tokyo or Fukushima residents, while educational background was associated with positive well-being and positive functioning in both Tokyo and Fukushima residents. Interventions to improve post-disaster well-being need to be implemented regardless of typical SES, such as annual income, educational background, and employment status.

Interestingly, the number of relocations was not significantly associated with well-being for either Fukushima or Tokyo residents. It is worth noting that the absolute value of β was small overall, although the low statistical power might be a factor in the insignificance. This implies that the number of relocations had a weaker effect on well-being than the SES. This finding could be explained by interpretations that the associations of well-being with the number of relocations were masked by those with SES, or that the quality of relocations (such as separation from family members) was a more important factor in well-being than the number of relocations.

Limitations

This study had some limitations. First, because the study was based on monitors registered with an online survey company, there could be a bias in the target population. Although age and gender were collected to match the actual distribution, a possibility of bias existed for other items. Second, since the survey was conducted 7 and a half years after the Fukushima disaster, a possible recall bias existed for the number of relocations. While well-being, psychological characteristics, and SES were based on the time of the survey,

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the number of relocations might be inaccurate, and the findings should be interpreted with caution. Third, this finding cannot be applied to the elderly, since the target age group was 20 to 59 years old. Fourth, the findings are not applicable to the acute phase immediately after the disaster. Fifth, application to other regions and disasters also requires caution. Sixth, while this study analyzed the associations of well-being with factors related to the Fukushima disaster, including radiation risk perception and the number of relocations, it did not fully investigate other disaster-related characteristics (e.g., bereavement, damage to homes). Seventh, the qualitative aspects of relocations after the disaster were not taken into account. Given that separation from family members has occurred in the wake of the Fukushima disaster,[25] future studies are necessary to analyze associations of well-being with not only the number of relocations but also the quality of relocations. The eighth limitation is that this study did not rule out the effects of events other than the disaster on psychological characteristics and SES. In the future, more detailed analysis of the associations of well-being with psychological characteristics and SES for specific non-disaster events is expected.

Conclusions

This study exploratively investigated the associations of well-being with psychological characteristics, SES, and number of relocations 7 and a half years after the Fukushima disaster. Findings of this study are summarized as follows:

- Well-being was classified into 5 scales: positive emotion, negative-free emotion, life satisfaction and general happiness, positive characteristics, and positive functioning. Of these, only negative-free emotion was weakly correlated with the other 4 well-being scales. Despite conceptual differences, the other 4 well-being scales were strongly correlated with each other and showed similarities in the strength of their associations with psychological characteristics, SES, and number of relocations.
- Among psychological characteristics and SES, psychological distress, mindfulness, and marital status were strongly associated with well-being among Fukushima residents. Contrarily, radiation risk perception after the Fukushima disaster did not play an important role in well-being. Furthermore, the number of relocations, health anxiety, annual household income, educational background, and employment status had weak or no association with well-being.
- Focusing on psychological distress is expected to have a significant impact on the maintaining or improving well-being after the disaster. Furthermore, assistance in avoiding unintended separation from their partners may be helpful.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/dmp.2025.102.

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