Association of psychological factors with advanced-level functional competency: Findings from the Aichi workers' cohort study, 2002–2019

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ABSTRACT

Objective: This study examined the longitudinal association of perceived stress, *ikigai,* and having someone one can count on in middle age with the advanced-level functional competency in older age, which is crucial for the maintenance of independent life among older adults. The issue is especially relevant in super-aged countries like contemporary Japan, where more and more older people live in a household consisting only of older people.

Methods: Data were collected in 2019 from a total of 1692 retirees of the Aichi Workers' Cohort Study participants in which baseline survey including psychological factors was conducted during their employment in 2002. Japan Science and Technology Agency Index of Competence (JST-IC) was used to measure the advanced-level functional competency. Multivariable-adjusted odds ratios (ORs) were obtained for having low JST-IC in later life by the degrees of psychological factors reported in the middle age adjusting for the presence of depressive mood in 2019.

Results: Those who were not sure about *ikigai* (OR: 2.02, 95 % CI: 1.33 to 3.08) and who have no one to count on (OR: 2.19, 95 % CI: 1.52 to 3.16) in the middle age were significantly associated with low JST-IC after retirement. Having much stress was significantly inversely associated with a low JST-IC (OR: 0.69, 95 % CI: 0.50 to 0.97).

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Conclusion: Having *ikigai* and someone reliable, and stress during middle age might play a role in preventing impaired advanced-level functional competency. Improved *ikigai* and increased social interaction and support might improve functional competency. Further research might explore avenues for improving *ikigai*.

1. Introduction

Most of the countries in the globe are aging but at different pace. Japan, already a super-aged country, is leading the change, and it is estimated to have one-third population of 65 years and older by the end of 2030 [1]. Currently, more than 60 % of households with older people consists only of older people in Japan and approximately 20 % of older people live in a single person household. Maintaining a higher level of competency of older people would be pivotal for the sustainability of such a society [2,3]. There is a possibility that psychological factors in middle age may be associated with the advanced-level functional competency in older age as recent studies have demonstrated that higher psychological wellbeing of older people is associated with a reduced cognitive impairment and functional disability after three years [4,5].

In the present study, we used the Japan Science and Technology Agency Index of Competence (JST-IC) tool to measure the advanced-level functional competencies of older people [6,7] and studied its relationships with psychological stress [8,9], someone

Baseline survey in 2002

6,648 participants responded to a self-administered questionnaire

Questionnaire sent to the retirees in 2019

(n = 2165)

Responded and provided consent

(n = 1698)

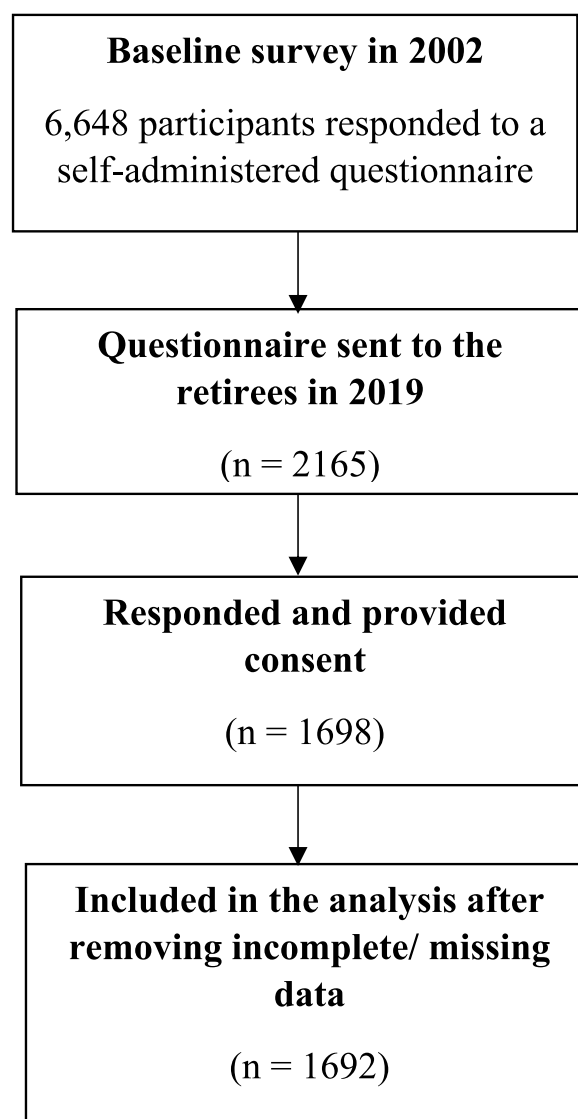**Included in the analysis after removing incomplete/ missing data**

(n = 1692)

Fig. 1. Flowchart for participant selection.

one can count on as a measure of social support, and *ikigai*, having a purpose in life [10,11] or a state of eudaimonic well-being [12] all assessed in the middle age. Psychological stress is a common issue and has been related to the presence and development of many physical and mental statuses. However, the relationship of stress with advanced-level functional competency has not been extensively studied and there are discrepancies in the findings [8,9]. While considering the perceived stress, an important factor might be the presence of someone to share the problems. The Japanese terminology for someone one can count on means that someone with whom one can share problems and often get suggestions, and it could be a friend, family member, colleague, or anyone that can play the role. This is a less-discussed concept and to our knowledge, no previous studies in Japan have considered "someone one can count on" as a contributing factor to declined advanced-level functional competency. Another relevant psychological factor among the middle-aged Japanese population is *ikigai*. *ikigai* is a Japanese intuitive term that represents the "meaning of life". Having *ikigai* indicates one's life is meaningful and worth living [10,11]. To our knowledge, no previous studies have explored the association between *ikigai* in middle age and advanced-level functional competency in later life.

Little is known whether psychological factors in middle age are related to later variation in advanced-level functional competency. It may be useful to identify such factors if they could be modified for the prevention of functional incompetency at an older age. Indeed, there is a possibility of having an association with psychological factors in middle age with the advanced-level functional competency in older age as recent studies have demonstrated that higher psychological wellbeing is associated with a reduced cognitive impairment and functional disability [4,5] which would closely have related to advanced-level functional competency.

We postulated that low perceived psychological stress, having someone one can count on and having *ikigai* in the middle age would be related to higher advanced-level functional competency in older age after retirement. Since advanced-level functional competency could be impaired in older people with depressive mood [9], and psychological factors we study may also be associated with the risk of depressive mood later in life [5], we modeled this variable as the confounding or intermediating factor in the relationship between psychological factors and advanced-level functional competency. In quest of testing the hypothesis, we analyzed the data from the Aichi Worker's Cohort study. To our knowledge, no previous study has explored the longitudinal association of psychological factors in middle-age with advanced-level functional competency evaluated with JST-IC later in life.

2. Methods

Description of the participants, variables and co-variates that were considered in the analyses, and the statistical methods have been described here.

2.1. Study participants and sample size

The Aichi Worker's Cohort study was initially established in 1997 and is ongoing among the civil servants of Aichi prefecture in Japan [13–15]. In the baseline survey in 2002, a total of 6648 participants responded to a self-administered questionnaire providing information on their lifestyle and medical history. Information related to perceived psychological stress, *ikigai,* and someone one can count on were also collected in the baseline survey. The eligible participants were the current employees of the local government of the Aichi prefecture aged 35 or over in 2002. In 2019, a questionnaire was sent through the postal mail to the 2165 retirees of the participants of the 2002 cohort. The questionnaire contained the JST-IC and Centre for Epidemiological Studies-Depression (CES-D) scales [16] along with medical history and lifestyle-related information.

One thousand six hundred and ninety-eight retirees provided consent and responded to the self-administered questionnaire (78.4 %). After excluding those with the missing data, a total of 1692 participants were analyzed in this analysis. The flow chart of participant selection is provided in Fig. 1.

After collecting data, data were entered into Claris FileMaker Pro 18 (Claris International Inc. Cupertino, CA, USA) and data ware cleaned and coded using IBM SPSS Statistics for Windows, Version 28.0 (IBM, Armonk, NY, USA).

2.2. Psychological variables at baseline

Stress was assessed by a question item "Do you have much stress in your daily life?" The responses were "very much", "much", "ordinary", and "little". Assessment of stress using a single item stress question has been explored previously and found effective among working population [17,18]. Ikigai was assessed by a question item "Do you have *Ikigai* or hari in your life?" Having *ikigai* indicates one's life is meaningful and worth living. *Hari* means springiness or tone and having *hari* in life indicates one life is filled with spirit or will-power. The responses for this question were "Yes, a lot", "Yes", "so so (average)", and "not sure (don't know)". Hari was added to the question since *ikigai* alone could mean hobbies, which was not the intention of the question. Someone one can count on was assessed by a question item "Can you count on anyone to talk over problems?"

2.3. JST-IC in 2018

JST-IC is a 16-item questionnaire to measure the competence of older adults at a higher level consisting of the following four domains: social engagement, technology use, information practice, and life management [6,7]. The English version of the JST-IC questionnaire [7] has been provided in Supplementary file 1. The total score (total score 16) of the JST-IC was categorized and dichotomized it using the median of the standard population [7]. Namely, a JST-IC score of 9 or less was labelled as low JST-IC or low advanced-level functional competency. The standard population was described as community-dwelling older people aged 65–84 years

selected using a stratified two-stage random sampling procedure [7]. Although there have not been any reports that determined the cut-off of JST-IC score with the gold standard to define lower advanced-level functional competency, we employed the score of 9 as the cut-off similarly to another study having a similar median JST-IC score [19].

2.4. Covariates

The sociodemographic and behavioral variables considered in this analysis were collected at baseline in 2002. Baseline age was categorized into two groups: ≥50 years and <50 years. Educational status was dichotomized as college or above, defined by age of graduation at 22 years of age or more. Job category was classified as office workers and others. Office workers were those performed administrative tasks. Other workers were doctors, nurses, laboratory researchers, field workers, etc. Smoking was dichotomized into ever and never smoked. Drinking of alcohol currently was defined as those who reported drinking at least once per week in 2002. Having an exercise habit was defined as that performed at least once a month and for 60 min or more in total in 2002. Overweight was defined if BMI (body mass index) ≥ 25 kg/m^2. Diseases history included a self-reported history of cardiovascular diseases, hypertension, diabetes, hypercholesterolemia, and cancer assessed at baseline. The depressive mood was defined if a participant has a modified CES-D score of 8 or above [20–22]. The modified CES-D scale consists of 11 items with a total score ranging from 0 to 33. The validity of the modified CES-D scale among the Japanese population has been demonstrated in previous research [23,24].

2.5. Statistical analysis

The proportion (%) of dichotomized variables of age, sex, educational status, job category, smoking, alcohol drinking, physical activity, obesity, and disease history were analyzed according to the degree of stress, "someone one can count on", and *ikigai* at baseline. The research objective was to explore the association of psychological factors in middle-age with advanced-level functional competency evaluated with JST-IC later in life. To achieve this, a longitudinal analysis was approached where logistic regression models were used to obtain multivariable-adjusted odds ratios (ORs) and 95 % confidence intervals (95 % CIs) for having low JST-IC later in life by the degrees of stress, *ikigai*, and "someone one can count on" reported in the middle age. These psychological factors were initially evaluated separately in multivariable models adjusted for age (continuous), sex, education, job category, smoking, alcohol drinking, exercise, overweight, and disease history. Then, an analysis in simultaneously-adjusted model including all the stress, *ikigai*, and "someone one can count on" was carried out. In addition, confounding or mediating effects of having depressive mood in the association of psychological factors with low JST-IC were also considered in both separately and simultaneously-adjusted multivariable logistic regression models. Additional analyses were performed to explore whether age (continuous) and sex would modify the association found in the main analysis by further including an interaction term between each exposure of interest multiplying age (continuous) or sex in the models above. A p-value less than 0.05 was considered to be of statistical significance.

2.6. Ethical consideration

The research was conducted in accordance with the relevant guidelines and regulations. All the participants provided written informed consent. Privacy of the participants were maintained throughout the process. The study was approved by the Ethics Review Committee of Nagoya University Graduate School of Medicine (approval number: 2007–0504) and Fujita Health University (approval

Table 1a
Baseline characteristics (proportion) of categories of age, sex, education, and job category according to the degree of stress, *ikigai*, and presence of someone the participant could count on, Aichi workers' Cohort Study, 2002.

Variables		Age, ≥50 years (%)	Sex, Male (%)	Education, College or above (%)	Job category, Office worker (%)
Stress	Very much (n = 190)	64.7	70.5	33.5	73.9
	Much (n = 680)	67.2	79.3	35.4	79.0
	Ordinary (n = 723)	73.6	80.5	31.4	79.2
	Little (n = 99)	74.7	81.8	30.3	69.7
Ikigai	Yes, a lot (n = 62)	76.9	80.0	32.3	71.0
	Yes (n = 541)	73.4	79.1	31.6	74.0
	So so (n = 886)	69.7	79.0	34.1	80.7
	Not sure (n-170)	60.1	78.6	33.5	78.6
Someone you can count on	Yes (n = 655)	68.2	75.4	32.0	72.1
	No (n = 509)	72.9	80.0	35.1	82.4
	I don't have worries (n = 525)	69.9	82.1	32.7	80.9

Stress was assessed by a question item "Do you have much stress in your daily life?"
Ikigai was assessed by a question item "Do you have *ikigai* or *hari* in your life?" Having *ikigai* indicates one's life is meaningful and worth living. *Hari* literally means springiness or tone and having *hari* in life indicates one life is filled with spirit or will-power.
Someone you can count on was assessed by a question item "Can you count on anyone to talk over problems?"
College or above education was defined by age of graduation at 22 years of age or more.
Office workers were office assistants and performed administrative tasks.

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3. Results

In this section, the characteristics of the participants has been provided first. Then, the factors associated with the psychological variables (stress, *ikigai*, and someone one can count on) are presented. Finally, the findings of the hypothesis testing is presented. According to the objective of the study, the hypothesis was as follows: low perceived psychological stress, having someone one can count on and having *ikigai* in the middle age would be related to higher advanced-level functional competency in older age.

The mean age, the proportion of participants aged 50 or over, and the proportion of men were 48.3 years, 48.4 %, and 77.5 % in the total participants, respectively.

At baseline, perceived stress was related to age. The proportion of participants aged 50 years and above was 64.7 % among "very much" while it was 74.7 % among "little" perceived stress categories. Similarly, perceived stress was associated with sex. The proportion of men was 70.5 % in those with very much stress, while it was 81.8 % in the little stress category. The proportion of respondents who completed education at the college level or above were 33.5 % in those with very much stress, and 30.3 % in the little stress group. The proportion of office workers was 73.9 % in the very much stress group, while 69.7 % in the little stress group (Table 1A). The proportions of ever smoked, current alcohol drinking, performing regular exercise, overweight, and having a positive diseases history were 43.7 %, 64.4 %, 51.9 %, 20.8 %, and 22.8 %, respectively in the very much stress category whereas 56.1 %, 80.8 %. 74.5 %. 18.0 % and 26.3 %, respectively in the little stress category (Table 1B). Similarly, *ikigai* was related to age, sex, education, job category, smoking habit, alcohol drinking, performing exercise, overweight, and positive history of the disease. The sociodemographic and behavioral variables were also related to the variable "someone one can count on".

The median of the JST-IC score in this population was 12. The prevalence of low JST-IC was 17.6 % in the total participants. The prevalence of low JST-IC in those having depressive mood was higher (31.8 %) than that in those without depressive mood (14.7 %, data not shown in tables). No association was found between "very much stress" or "much stress" in the middle age and low JST-IC score in the later age in the separate multivariable-adjusted model (Table 2). However, in the simultaneously-adjusted model, those who responded "much stress" were significantly not likely to have a low JST-IC score (OR: 0.69, 95 % CI: 0.50 to 0.97). Those who were not sure about *ikigai* were significantly associated with low JST-IC in the separate multivariable-adjusted model (OR 2.27, 95 % CI: 1.51 to 3.40) and simultaneously-adjusted model (OR: 2.02, 95 % CI: 1.33 to 3.08). Participants who responded "Yes" regarding having *Ikigai*, were less likely to have low JST-IC in both the models with OR of 0.63, 95 % CI: 0.45 to 0.89 and 0.69, 95 % CI: 0.48 to 0.98 respectively. Participants who have no one to count on were prone to be low JST-IC showing OR of 2.48, 95 % CI: 1.75 to 3.51, and 2.19, 95 % CI: 1.52 to 3.16, respectively.

Having not sure *ikigai* and no one to count on were associated with low JST-IC even in the model adjusting for depressive mood in 2019, while the association of much stress with low JST-IC was similar to the simultaneously-adjusted model after adjusting for depressive mood (OR: 0.67, 95 % CI: 0.48 to 0.94).

Table 1b
Baseline characteristics (proportion) of categories of smoking, alcohol drinking, physical activity, obesity, and diseases history in 2002 and depressive mood in 2019 according to the degrees of stress, *ikigai*, and presence of someone the participant could count on, Aichi workers' Cohort Study.

Variables		Smoking, ever (%)	Alcohol drinking, current (%)	Exercise, yes (%)	Obesity, (%)	Diseases history, yes (%)	Depressive mood in 2019, (%)
Stress	Very much (n = 190)	43.7	64.6	51.9	20.8	22.8	24.7
	Much (n = 680)	49.9	73.4	62.6	24.3	29.0	19.6
	Ordinary (n = 723)	51.5	71.2	65.8	22.0	24.7	12.9
	Little (n = 99)	56.1	80.8	74.5	18.0	26.3	6.1
Ikigai	Yes, a lot (n = 62)	43.1	75.4	73.0	30.6	26.2	10.8
	Yes (n = 541)	49.2	73.8	71.4	22.6	27.8	9.9
	So so (n = 886)	51.2	71.1	61.0	22.3	25.1	17.6
	Not sure (n-170)	52.9	69.6	48.8	20.8	26.7	33.5
Someone you can count on	Yes (n = 655)	46.2	68.8	65.2	20.9	24.1	14.2
	No (n = 509)	51.3	72.3	59.5	25.7	28.3	26.3
	I don't have worries (n = 525)	54.7	75.7	65.4	21.8	26.4	9.7

Stress was assessed by a question item "Do you have much stress in your daily life?"
Ikigai was assessed by a question item "Do you have *ikigai* or *hari* in your life?" Having *ikigai* indicates one's life is meaningful and worth living. *Hari* literally means springiness or tone and having *hari* in life indicates one life is filled with spirit or will-power.
Someone you can count on was assessed by a question item "Can you count on anyone to talk over problems?"
Ever smoker was defined as current or former smoker.
Currently drinking of alcohol was defined as those who reported drinking at least less than once per week.
Having an exercise habit was defined as that performed at least once a month and for 60 min or more in total.
Obesity was defined if body mass index ≥ 25 kg/m^2.
Diseases history includes self-reported history of cardiovascular diseases, hypertension, diabetes, hypercholesterolemia, and cancer.
The depressive mood was defined if a participant has a modified CES-D score of 8 or above.

Table 2

Odds ratios (ORs) and 95 % confidence intervals (95 % CIs) of having low JST-IC* in 2019 according to the degrees of stress, *ikigai*, and presence of someone the participant could count on at baseline, Aichi Workers' Cohort Study, 2002–2019.

Variables		Low JST-IC (2019)			
		Prevalence, %	Separate multivariable model	Simultaneously-adjusted model	Further adjusted model for depressive mood in 2019
Stress (2002)	Very much	20.4	0.94 (0.58–1.51)	0.70 (0.42–1.18)	0.67 (0.40–1.14)
	Much	15.6	0.82 (0.60–1.13)	0.69 (0.50–0.97)	0.67 (0.48–0.94)
	Ordinary	17.8	Ref	Ref	Ref
	Little	24.5	1.26 (0.71–2.23)	1.50 (0.82–2.74)	1.62 (0.89–2.97)
***Ikigai* (2002)**	Yes, a lot	8.3	0.38 (0.13–1.09)	0.39 (0.13–1.13)	0.40 (0.14–1.17)
	Yes	12.1	0.63 (0.45–0.89)	0.69 (0.48–0.98)	0.72 (0.50–1.03)
	So so	18.3	Ref	Ref	Ref
	Not sure	34.1	2.27 (1.51–3.40)	2.02 (1.33–3.08)	1.90 (1.24–2.91)
Someone you can count on (2002)	Yes	11.9	Ref	Ref	Ref
	No	25.3	2.48 (1.75–3.51)	2.19 (1.52–3.16)	2.07 (1.42–2.99)
	I don't have worries	17.3	1.44 (0.99–2.08)	1.21 (0.82–1.78)	1.24 (0.84–1.83)

Ref indicates reference.

*: prevalence of low JST-IC in each response (e.g., 20.4 % of participants who responded "very much" to daily stress in 2002 had low JST-IC in 2019.). Stress was assessed by a question item "Do you have much stress in your daily life?"

Ikigai was assessed by a question item "Do you have ikigai or hari in your life?" Having ikigai indicates one's life is meaningful and worth living. Hari literally means springiness or tone and having hari in life indicates one life is filled with spirit or will-power.

Someone you can count on was assessed by a question item "Can you count on anyone to talk over problems?"

*JST-IC indicates Japan Science and Technology Agency Index of Competence, which is a 16-item questionnaire to measure the competence of older adults at a higher level consisting of the following four domains: social engagement, technology use, information practice, life management.

Separate multivariable model included age, sex, education, job category, ever smoking, current alcohol drinking, having an exercise habit, obesity, and disease history.

Simultaneously-adjusted model: stress, ikigai, and someone you can count on were simultaneously included in the multivariable model adjusted for the same variables in the separate multivariable model.

Further-adjusted model included depressive mood in 2019 on top of simultaneously-adjusted model.

Age (continuous) and sex did not modify the association of stress, *ikigai*, and "someone you can count on" with JST-IC in the interaction analysis (all the p-values for interaction terms ≥0.05) (data not shown).

4. Discussion

This study identified the longitudinal association of perceived stress, *ikigai*, and someone one can count on for support with low JST-IC. Participants who are not sure about *ikigai*, those who do not have anyone to share and get support at middle age were more prone to be experiencing declined functional competency at a late age. Perceived stress was not associated with low JST-IC except for those who responded "much stress" were significantly less prone to have a lower JST-IC in the simultaneously-adjusted model. Those who are not sure about *ikigai* and those who do not have anyone to count on were significantly associated with low JST-IC.

It is interesting to note that, there was no association between perceived stress and lower JST-IC (except the borderline significant association demonstrating participants having much stress are less likely to have low JST-IC). To our knowledge, no previous studies explored this association using JST-IC. Similar findings have been provided by another cohort study conducted among the Caucasian people that depicted no association between perceived stress and impaired cognitive function in older adults [25]. An analysis of three cohort populations also reported the longitudinal association of higher cognitive simulation at work and lower risk of having dementia [26]. However, more studies have demonstrated an association between higher perceived stress and cognitive decline in a cross-sectional way [27–30]. The borderline inverse (with "much stress") or no association (with "very much" stress) between perceived stress and lower JST-IC might be due to that we did not update stress status during the follow-up as all the participants of the present study experienced retirement which may relieve work-related stress.

As this is the very first exploration of the association between *ikigai* in middle age and advanced level functional competency using JST-IC later in life, there was no study to compare. In this study, a formatted scale was not used to assess the *ikigai*. However, other studies have used similar approach by asking one simple question to get an appropriate response regarding having *ikigai* in life. In this study, it was found that the advanced-level functional competency at a later age was high for the participants having *ikigai* in middle age. Thus, the finding of the present study might be comparable to another cohort study conducted in Sendai city in Japan that explored the longitudinal association between *ikigai* and 12-year functional competency using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) [31]. The Japan Gerontological Evaluation Study (JAGES) also demonstrated the association between having *ikigai* with lower risk of functional disability [5]. However, the JAGES study used instrumental daily activities of living sclae to measure functional disability. These results together emphasized *ikigai* as an important psychological factor leading to negative functional competency in later life.

In this research, a factor "someone one can count on" was considered, which is sharing and getting support and guidance from a friend to solve a problem in a broader aspect. Participants of this study who do not have anyone to share in the middle age were at a

higher risk of having a lower JST-IC score. As per the findings of the present study, having someone to share and get support in middle age might play a role in having a higher advanced-level functional competency at a later age.

The findings of this study generate newer thoughts for improving advanced-level functional competency. The longitudinal association between perceived stress, *ikigai*, and getting support from someone may suggest potential usefulness of the idea of implementing interventions in early or midlife in having a higher level of advanced level functional competency in later life. Some researchers have explored the factors associated with *ikigai* [32] such as community-oriented social support groups, increased opportunities for social interaction, peer consultation, etc. that can be considered as an example of such initiatives and can be considered while designing such intervention study. The ongoing cohort studies among Japanese population may consider exploring the association of psychological factors with advanced-level functional competency to strengthen the evidence base. Future researches might consider assessment of stress using a valid scale. As there is no study describing the impact of having "someone one can count on" in relation to advanced-level functional competency, there is scope to consider this factor in future research.

The strength of this study is the longitudinal exploration of the factors with the outcome. The JST-IC tool is an updated and timely initiative for assessing advanced-level functional competency among older people in recent times. Further research can be conducted exploring the associated factors of having lower competency using this tool. For analytical robustness, the current study has considered both separate multivariable models and a simultaneously-adjusted model to observe any fluctuation of the association. In addition, the modifiable effect of age and sex were considered which further strengthens the analysis. Despite these sturdy methodological approaches, this study is not devoid of limitations. The advanced-level functional competency was not measured at baseline. However, it is reasonable to presume that the advanced-level functional competency was not low for the middle-aged participants at baseline. Also, stress was assessed using a single item question although there are evidence that a single item question could be used.

5. Conclusions

In conclusion, psychological factors such as *ikigai*, and having someone to count, are longitudinally associated with lower advanced-level functional competency at a later age. Perceived stress was not associated with advanced-level functional competency except a borderline association between much stress and low JST-IC in a negative direction. It will be beneficial to improve *ikigai* and increase social interaction and support for the prevention of impaired functional competency.

Ethics approval and consent to participate

All methods were performed in accordance with the relevant guidelines and regulations of the Helsinki declarations. The study was approved by the Bioethics Review Committees of Nagoya University Graduate School of Medicine (approval number: 2007–0504) and Fujita Health University (approval number: HM18-246). Signed informed written consent was taken from all the participants.

Consent for publication

Not applicable.

Data availability statement

The datasets generated and/or analyzed during the current study are not publicly available due to ethical concerns but are available from the corresponding author on reasonable request after appropriate procedures including approval from the institutional ethics review committee.

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CRediT authorship contribution statement

K.M. Saif-Ur-Rahman: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Young Jae Hong:** Writing – review & editing. **Yuanying Li:** Funding acquisition, Methodology, Writing – review & editing. **Masaaki Matsunaga:** Writing – review & editing. **Zean Song:** Writing – review & editing. **Masako Shimoda:** Writing – review & editing. **Abubakr Al Shoaibi:** Writing – review & editing. **Yupeng He:** Writing – review & editing. **Md Razib Mamun:** Writing – review & editing. **Yukiko Hirano:** Writing – review & editing.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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List of abbreviations

BMI   Body mass index.
CES-D   Centre for Epidemiological Studies-Depression.
CI   Confidence interval.
CVD   Cardiovascular diseases.
JAGES   Japan Gerontological Evaluation Study
JST-IC   Japan Science and Technology Agency Index of Competence
OR   Odds ratio
TMIG-IC   Tokyo Metropolitan Institute of Gerontology Index of Competence

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e21931.

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