

# Impact of Annual Health Checkups on Five-Year Weight Gain in Japan: Considering Behavioral Change Stages in the Transtheoretical Model

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## Abstract

### Background

Obesity is a critical public health issue because this common disease leads to increased mortality. Therefore, controlling weight is essential. We aimed to evaluate whether undergoing health checkup examinations at least annually leads to better weight management.

### Methodology

This longitudinal study utilized the health checkup examination data collected between April 2014 and March 2019 at the Seirei Health Care Division in Japan. Participants whose weight was measured in 2014 and 2019 were included. All analyses were performed according to sex and the three categories of health checkup examination frequency (twice, three to four times, and five to six times over five years). One-way analysis of variance (ANOVA) and trend analysis were conducted on the average weight differences between 2014 and 2019. Covariance analysis was performed using age, body mass index, and the categories of the behavioral change stages in the transtheoretical model in 2014 as covariates in the one-way ANOVA. Subgroup analyses were conducted for two age groups:  $\geq 65$  and  $< 65$  years.

### Results

A total of 84,078 males and 51,418 females were included. The mean age (standard deviation) in 2014 was 44.2 (13.1) and 46.7 (13.2), respectively. The more frequently weight was measured, the less weight was gained after five years in both sexes; the average weight gain was 1.32, 1.17, and 0.95 kg in males and 1.26, 0.96, and 0.78 kg in females in the twice, three to four times, and five to six times frequency groups, respectively. The *P*-values for the one-way ANOVA, trend analysis, and covariance analysis were all  $< 0.05$ . This trend was true for those aged  $< 65$  years, whereas in those aged  $\geq 65$  years, weight loss was noticeable.

### Conclusions

An association between weight gain after five years and the frequency of health checkup examinations was revealed among individuals aged  $< 65$  years. Weight gain may be controlled with annual health checkup examinations.

**Categories:** Preventive Medicine, Public Health, Occupational Health

**Keywords:** health check-up examination, obesity, stages of change, weight control, weight gain

## Introduction

Obesity is a major public health concern worldwide. According to the World Health Organization, one in eight adults aged  $\geq 18$  years were obese in 2022, and the prevalence of obesity more than doubled between 1990 and 2022 [1]. Moreover, obesity leads to increased mortality through complications such as cardiovascular disease, some types of cancers, hypertension, diabetes mellitus, and dyslipidemia [2,3]. Weight control is essential: weight loss for people with obesity and weight maintenance for people with healthy weights.

Effective ways of weight management include self-monitoring, which mainly consists of recording intake, physical activity, and weighing [4]. Through self-monitoring, people become more aware of their behavioral or activity patterns and thus can change their lifestyles [5]. Among the ways of self-monitoring, recording weight or self-weighing is easy to do by oneself, costs less, and is not accompanied by adverse psychological events [6-8]. Frequent self-weighing is favorable for weight management [4,7,9,10], but regular weight management is very difficult to maintain [6,11].

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Japan has three main health checkup systems. First, employers are legally obliged to have their employees undergo regular health checkup examinations at least annually [12]. The regular health checkup examination includes 11 items, including an examination of height and weight and blood and urine tests [13]. Second, all people aged 40-74 years have the right to undergo *Specific Health Checkups (SHCs)* annually. The SHC system was initiated in 2008, and it aims to detect diseases related to metabolic syndrome in their earlier stages. In SHCs, examinations are performed as per regular health checkup examinations [14-16]. Third, in Japan, the Comprehensive Health Checkup System (Ningen Dock) was established and basically, those who undergo this belong to high socioeconomic status; they willingly undergo this to have diseases detected in their earlier stages or to maintain their health through prevention at their own expense or partially financially subsidized by the company [13,17-19]. In the Ningen Dock, people have more types of examinations than in regular health checkup examinations or SHCs. Therefore, in Japan, many people, especially those aged 40-74 years, undergo annual examinations for height and weight. In a sense, this health checkup examination is an opportunity for mandatory annual weighing, and this regular weighing is expected to have a similar effect on weight control as self-weighing. Hereafter, health checkup examinations refer to regular health checkup examinations, SHCs, and the Ningen Dock.

However, few studies have focused on the impact of the frequency of health checkup examinations [20,21]. The examinations are performed to maintain their health through prevention or detect diseases as soon as possible, and it is essential to research the impact. To our knowledge, there is no study focusing on the association between the frequency of examinations and weight control. Moreover, the previous studies have limitations where health awareness was not considered. This study aimed to evaluate whether the frequency of health checkup examinations is associated with weight control, considering health awareness.

## Materials And Methods

### Study design and setting

This longitudinal study utilized the health checkup examination and Comprehensive Health Checkup System (Ningen Dock) data collected in the Seirei Health Care Division (hereafter referred to as *Seirei*). Data were collected from April 2014 to March 2019 at five Seirei facilities in Shizuoka Prefecture: three facilities in Hamamatsu City and two in Shizuoka City. Hamamatsu City, located in the western part of Shizuoka Prefecture, has the largest population in Shizuoka Prefecture and is one of the government ordinance-designated cities. Shizuoka City is located in the central part of Shizuoka Prefecture and is its capital. All examinees are required to submit the questionnaire before they undergo the health checkup examination or Ningen Dock at Seirei.

### Eligibility of participants

Participants whose weight was measured during health checkup examinations in 2014 and 2019 were included. Those whose age as of 2014 was not known were excluded.

### Variables

We used the first data recorded in a year if the participants underwent a health checkup examination twice or more in the same year. The number of times the participants underwent health checkup examinations between 2014 and 2019 was categorized as twice, three to four times, and five to six times.

The health checkup examination questionnaire included the following question (Appendices A-C), based on the stages of change in the transtheoretical model [22]: “Do you want to improve your lifestyle habits of eating and exercising?” Each answer is equivalent to the stage of change: “Do not want to” corresponds to the pre-contemplation phase, “Do want to (within 6 months)” corresponds to the contemplation phase, “Want to improve in the near future (within a month)” corresponds to the preparation phase, “Already trying to improve (less than 6 months)” corresponds to the action phase, and “Already trying to improve (over 6 months)” corresponds to the maintenance phase. We divided these five phases into three categories, referring to previous studies [23,24]: the pre-contemplation, contemplation, and preparation phase, the action phase, and the maintenance phase. The outcome was the difference in body weight between 2014 and 2019.

### Statistical analysis

We described the participants' characteristics by sex and the frequency of health checkup examinations, the mean and standard deviation (SD) of age and body mass index (BMI), and the proportion of each category of the stages of change.

The average and SD of the difference in body weight between 2014 and 2019 were calculated according to sex and the three categories of the stages of change. One-way analysis of variance (ANOVA) was performed between the categories of the frequency of health checkup examinations according to sex. Trend analysis was also performed to verify whether weight gain monotonically decreased as the frequency of health checkup examinations increased. The interaction between the number of times participants underwent a health checkup examination between 2014 and 2019 and the age group with a cutoff of 65 years for

population aging rate criteria (<65 years and ≥65 years) was calculated using two-way ANOVA. Analysis of covariance (ANCOVA) was performed by inserting age, BMI, and the categories of the stages of change in 2014 as covariates into the one-way ANOVA according to sex. Additionally, considering the effect of weight loss due to frailty [25-29], one-way ANOVA and ANCOVA were also conducted by age group (<65 years old and ≥65 years).

IBM SPSS Statistics, version 26 (IBM Corp., Armonk, NY) was used for all statistical analyses.

## Results

In total, 84,078 males and 51,418 females were included in this analysis, and the number of those whose age as of 2014 was not known was zero. Table 1 shows the characteristics of the participants in 2014 according to sex, age group, and the number of times they underwent health checkup examinations between 2014 and 2019. For males and females, the largest number of participants had health checkup examinations almost every year (five to six times in total) at 93.9% (78,991/84,078) for males and 89.8% (46,190/51,418) for females. This trend was similar by age group. The mean age (standard deviation) was 44.2 (13.1) in all males and 46.7 (13.2) in all females; it was approximately 44 years in males, regardless of the frequency of health checkup examinations, whereas in females, it was higher in the group who underwent health checkup examinations five to six times (46.9 years) than in the other groups (approximately 45 years). The average BMI was almost the same for each sex, regardless of the frequency of health checkup examinations: approximately 23 kg/m<sup>2</sup> in males and 21.5 kg/m<sup>2</sup> in females. Regarding the stages of change, the largest proportion of participants were in the contemplation and preparation phases among all individuals aged <65 years for both sexes, whereas the largest proportion were in the action and maintenance phases among individuals aged ≥65 years (Appendix D).

Frequency of health checkup examinations between 2014 and 2019	n	Age (years)	BMI (kg/m <sup>2</sup> )		Stages of change					
					Pre-contemplation		Contemplation/preparation		Action/maintenance	
					Average (SD)	Average (SD)	NA*	n (%)	n (%)	n (%)
All										
Males										
Twice	696	44.2 (13.1)	23.4 (3.6)	1	138	(20.2)	370	(54.3)	174	(25.5)
3 to 4 times	4391	44.7 (13.4)	23.4 (3.5)	4	851	(19.6)	2326	(53.7)	1154	(26.6)
5 to 6 times	78991	44.1 (13.1)	23.2 (3.5)	63	16934	(21.8)	39372	(50.8)	21267	(26.9)
Females										
Twice	637	45.0 (12.4)	21.7 (3.6)	1	71	(11.3)	408	(65.2)	147	(23.5)
3 to 4 times	4591	44.6 (13.1)	21.5 (3.5)	2	647	(14.3)	2752	(60.8)	1127	(24.9)
5 to 6 times	46190	46.9 (13.2)	21.6 (3.6)	16	6460	(14.2)	26412	(58.3)	12467	(27.5)
<65 years old										
Males										
Twice	642	42.2 (11.4)	23.5 (3.6)	1	125	(19.5)	351	(54.7)	155	(24.1)
3 to 4 times	4039	42.5 (11.6)	23.5 (3.6)	4	780	(19.3)	2211	(54.7)	989	(24.5)
5 to 6 times	73289	42.2 (11.5)	23.3 (3.5)	61	15963	(21.8)	37735	(51.5)	18288	(25.0)
Females										

Twice	596	43.3 (10.9)	21.7 (3.6)	1	64	(10.7)	392	(65.8)	129	(21.6)
3 to 4 times	4259	42.7 (11.4)	21.4 (3.5)	1	585	(13.7)	2643	(62.1)	973	(22.8)
5 to 6 times	41856	44.6 (11.4)	21.6 (3.6)	14	5754	(13.7)	24933	(59.6)	10405	(24.9)
≥65 years old										
Males										
Twice	54	68.9 (4.6)	22.8 (2.5)	0	13	(24.1)	19	(35.2)	19	(35.2)
3 to 4 times	352	69.5 (4.6)	22.7 (2.8)	0	71	(20.2)	115	(32.7)	165	(46.9)
5 to 6 times	5702	69.3 (4.4)	23.2 (3.5)	2	971	(17.0)	1637	(28.7)	2979	(52.2)
Females										
Twice	41	69.5 (5.2)	21.6 (2.9)	0	7	(17.1)	16	(39.0)	18	(43.9)
3 to 4 times	332	69.2 (5.0)	22.0 (3.3)	1	62	(18.7)	109	(32.8)	154	(46.4)
5 to 6 times	4334	69.6 (5.4)	21.8 (3.1)	2	706	(16.3)	1479	(34.1)	2062	(47.6)

**TABLE 1: Participants' characteristics in 2014 by sex and frequency of health checkup examinations.**

There are no missing values for age.

\*NA expresses the number of missing values.

BMI, body mass index; SD, standard deviation

Table 2 shows that among all ages for both sexes, the more frequently the participants had health checkup examinations, the smaller the amount of weight gain from 2014 to 2019 was. In males, the average weight gain was 1.32 kg in the *twice* frequency group and 0.95 kg in the *five to six times* frequency group, and in females, the average was 1.26 kg in the *twice* frequency group and 0.78 kg in the *five to six times* frequency group. One-way ANOVA and trend analysis resulted in  $P < 0.001$  for males and females. Among people aged <65 years, the results were similar. However, among people ≥65 years of age, weight loss was observed in most categories, and no obvious trends were found. The subgroup effects of the number of times participants had health checkup examinations between 2014 and 2019 were significantly different from each other for the age subgroup (<65 and ≥65 years) ( $P$  for interaction < 0.001).

Frequency of health checkup examinations between 2014 and 2019	Males				Females			
	n	Weight gain* (kg)	P-value†	P-value‡	n	Weight gain* (kg)	P-value†	P-value‡
		Average (SD)	(F-value)†	(JT statistics)‡		Average (SD)	(F-value)†	(JT statistics)‡
All								
Twice	696	1.32 (4.61)			637	1.26 (4.09)		
3 to 4 times	4391	1.17 (4.65)	<0.001 (6.560)	<0.001 (-3.486)	4591	0.96 (4.65)	<0.001 (8.414)	<0.001 (-3.631)
5 to 6 times	78991	0.95 (4.33)			46190	0.78 (4.33)		
<65 years old								
Twice	642	1.48 (4.65)			596	1.30 (4.11)		
3 to 4 times	4039	1.30 (4.73)	<0.001 (7.585)	<0.001 (-3.951)	4259	1.09 (3.84)	<0.001 (7.208)	<0.001 (-3.432)
5 to 6 times	73289	1.06 (4.39)			41856	0.90 (3.60)		
≥65 years old								
Twice	54	-0.65 (3.48)			41	0.61 (3.58)		
3 to 4 times	352	-0.34 (3.26)	0.790 (0.235)	0.691 (0.397)	332	-0.72 (3.22)	0.013 (4.335)	0.216 (1.238)
5 to 6 times	5702	-0.40 (3.08)			4334	-0.36 (3.02)		

**TABLE 2: Association between the amount of weight gain and health checkup examination frequency.**

\*Weight gain is calculated from the weight difference between 2014 and 2019.

†P-value and F-value are the results of ANOVA.

‡P-value and JT statistic are the results of trend analysis.

SD, standard deviation; ANOVA, analysis of variance; JT, Jonckheere-Terpstra

Table 3 shows that even after accounting for age, BMI, and stages of change categories using ANCOVA, an association remained between the frequency of health checkups and the amount of weight gain, as observed in the one-way ANOVA. Among participants younger than 65 years, the average weight gain was higher than that of the overall group, with a statistically significant association. In males, the average weight gain was 1.47 kg in the *twice* frequency group and 1.06 kg in the *five to six times* frequency group. In females, the average weight gain was 1.30 kg in the *twice* frequency group and 0.93 kg in the *five to six times* frequency group. Among people ≥ 65 years of age, similar to the ANOVA result, weight loss was observed in most categories, and no obvious trends were found.

Frequency of health checkup examinations between 2014 and 2019	Males			Females		
	n	Weight gain* (kg)	P-value (F-value)	n	Weight gain* (kg)	P-value (F-value)
		Average (SD)			Average (SD)	
All ages						
Twice	682	1.31 (4.59)		626	1.25 (4.09)	
3 to 4 times	4331	1.16 (4.66)	<0.001 (8.96)	4526	0.97 (3.82)	0.011 (4.47)
5 to 6 times	77517	0.95 (4.33)		45331	0.78 (4.53)	
<65 years old						
Twice	631	1.47 (4.64)		585	1.30 (4.12)	
3 to 4 times	3980	1.29 (4.74)	<0.001 (10.61)	4201	1.10 (3.83)	0.013 (4.34)
5 to 6 times	71930	1.06 (4.39)		41085	0.93 (3.58)	
≥65 years old						
Twice	51	-0.66 (3.45)		41	0.62 (3.58)	
3 to 4 times	351	-0.33 (3.26)	0.095 (0.31)	325	-0.70 (3.22)	0.011 (4.54)
5 to 6 times	5587	-0.42 (3.07)		4246	-0.36 (3.01)	

**TABLE 3: Association between weight gain and health checkup frequency, adjusted for covariates.**

Covariance analysis was performed, adjusting for age, body mass index (BMI), and the three categories of the stages of change, except in the groups of all ages and those younger than 65 years among males. In these groups, covariance analysis was adjusted for BMI and the stages of change categories, as there was an interaction between health checkup frequency and age. The P-value and F-value represent the results of the covariance analysis.

\*Weight gain is calculated from the weight difference between 2014 and 2019 for the age subgroups (<65 and ≥65 years).

SD, standard deviation

## Discussion

In our study, we found that the more frequently the participants undertook health checkup examinations, the smaller the amount of weight gain among those <65 years of age, considering health awareness. To our knowledge, this is the first study to examine the association between weight-gain control and the frequency of health checkup examinations. Moreover, this study showed the result, considering health awareness, although the previous studies had the limitation of not considering it [20].

The finding in this study was consistent with that of previous studies examining the effect of regular self-weighing [4,7,9,10]. However, in the studies, the frequencies were daily or monthly. This study suggests that even annual weighing is effective in weight control, which is novel. The effect of regular self-weighing for weight control has been hypothesized to be that people become aware of their lifestyle behaviors and try to change them through regular self-weighing [5]. When this hypothesis is applied to our study, the following two mechanisms are expected. First, regular health checkup examinations are an opportunity to review their lifestyle behaviors or weight itself; individuals may review them when they see the results of their weight measurement or lab data at the time of health checkups or before the checkups so that their results are worse. Second, we must consider the effect of the opportunity to discuss health with medical staff and physicians, for example, at the examination or at the specific health guidance after SHC provided by specialists such as public health nurses [13-18]. Physician examination is essential for any type of health checkup examination. Specific guidance is not provided for all participants undergoing SHCs but rather for participants estimated to be at high risk of metabolic syndrome based on the SHC data [14,16,30,31]. Previous studies have revealed that discussing health with medical staff or motivational interviewing can lead to weight loss [32-34]. However, this is considered ineffective on an annual basis. This study suggests that annually discussing health with medical staff can have a long-term effect on weight control, although the effect may be small.

In this study, when age was divided into two groups (<65 and ≥65 years), the association between the frequency of health checkup examinations and weight gain was only revealed in the <65 years age group. This can be attributed to two main factors. First, there is an increase in the prevalence of frailty among people aged ≥65 years [25-27], and weight loss is one of the main symptoms of frailty [28,29]. The prevalence of frailty among Japanese individuals aged ≥65 years is reported to be 7.4%, with a prevalence of approximately 2% in the late 60s, which increases dramatically, reaching approximately 20% in the early 80s [25]. Second, there is an increasing incidence rate of diseases that lead to weight loss, such as cancer [35]. In this study, the number of people who underwent health checkup examinations only twice between 2014 and 2019 was very small. Considering that dieting is controversial in older people with obesity or overweight [33], there should be a focus on the possibility of weight control through frequent health checkup examinations among people < 65 years of age.

This study had several limitations. First, we only showed the association between the frequency of health checkup examinations and the amount of weight gained after five years, and caution should be taken when determining the direction of causality. Second, this study had selection bias because participants who had never undergone a health checkup examination or had the examination either in 2014 or 2019 were excluded. Furthermore, most participants aged ≥65 years were estimated to be retired, and these types of health checkup examinations are not mandatory. Among people aged ≥65 years, those who voluntarily underwent health checkup examinations both in 2014 and 2019 were included in this study, which may have led to selection and survival biases. Third, we did not consider lifestyles at baseline and time-dependent covariates, such as annual weight gain or loss, changes in lifestyles, including self-weighing, the occurrence of diseases affecting the change in weight (such as malignancy), and socioeconomic status, including occupation. Fourth, what type of health checkup examinations (the regular health checkup examinations, SHCs, or Ningen Dock) was not included in the data set of this study? It is possible that the results differed depending on the type of health checkup examinations, considering the characteristics of each examination. Finally, the proportion of those who received specific health guidance was not clear in this study, and the additional effect of the guidance on weight control could not be estimated.

## Conclusions

This study concludes that annual health checkup examinations can help control weight gain in individuals under 65. It also highlights that the health checkup examination system may be beneficial for weight management in the broader population that undergoes regular examinations.

The findings indicate that Japanese individuals under 65 who underwent more frequent assessments of their body weight during health checkup examinations managed to control their weight better over five years, even after accounting for health awareness. This conclusion is drawn from health checkup examinees data in Japan between fiscal years 2014 and 2019. Further research should be conducted to examine whether regular health checkup examinations can prevent obesity or its progression using different data.

## Appendices

### Appendix A

一般健康診断 問診票

Questionnaire Sheet for General Health Examinations

健康保険被保険者証等（健康保険証）に記載されている記号、番号（枝番）、保険者番号を転記してください。記載いただいた場合は、記号・番号を健診結果とともに加入する保険者へ提供し、健診結果の管理に活用いたします。  
Please enter the number, branch (sub)-number, and insurer number on your health insurance card. We provide your insurer with the number and branch-number along with your health examination results for the insurer's management of those results.

記号：

Number:

番号（枝番）：  -

Branch (Sub)-number:

保険者番号：

Insurer number:

団体・会社名：

Organization/Company:

所属部署名：

Department & Section:

氏名

Name:

生年月日： 年 月 日 年齢： 歳 性別： 男・女  
Date of Birth: Y M D Age: years old Sex: Male/Female

本問診票は、事業者が労働者の健康状態を把握し、労働時間の短縮、作業転換等の事後措置を行い、脳・心臓疾患の発症の防止、生活習慣病等の増悪防止を図るという目的において使用されます。

This questionnaire sheet will be carried out to ensure that businesses understand the health conditions of their workers, and so that follow-up measures such as reducing the number of hours worked and changing the kind of work carried out by the worker can be implemented with the aim of preventing brain diseases, heart diseases, and the worsening of lifestyle-related illnesses, etc.

分類 Category	No.	質問項目 Questions	回答 Answers
既往歴 Medical history	1	医師から、脳卒中（脳出血、脳梗塞等）にかかっているといわれたり、治療を受けたことがありますか。 Have you ever been told by the doctor you have had a stroke (cerebral hemorrhage, brain infarction, etc.) and received treatment?	①はい Yes ②いいえ No
	2	医師から、心臓病（狭心症、心筋梗塞等）にかかっているといわれたり、治療を受けたことがありますか。 Have you ever been told by the doctor you have a heart disease (angina pectoris, myocardial infarction, etc.) and received treatment?	①はい Yes ②いいえ No
	3	医師から、慢性腎臓病や腎不全にかかっているといわれたり、治療（人工透析など）を受けていますか。 Have you ever been diagnosed as having chronic kidney disease or kidney failure and received treatment (dialysis therapy)?	①はい Yes ②いいえ No
	4	医師から、貧血といわれたことがありますか。 Have you ever been diagnosed as anemic?	①はい Yes ②いいえ No
（うち服薬歴） Medication history	5	現在、aからeの薬を使用していますか* Are you taking the following medicines at present?*	
	a	a. 血圧を下げる薬 a. Medication to reduce blood pressure	①はい Yes ②いいえ No
	b	b. 血糖を下げる薬又はインスリン注射 b. Medication to reduce blood sugar or insulin injection	①はい Yes ②いいえ No
7	c. コレステロールや中性脂肪を下げる薬 c. Medication to reduce your level of cholesterol or of neutral fat	①はい Yes ②いいえ No	
（うち喫煙歴） Smoking history	8	現在、たばこを習慣的に吸っている者* （※「現在、習慣的に喫煙している者」とは、「合計100本以上、又は6ヶ月以上吸っている者」であり、最近1ヶ月間も吸っている者） Are you currently a heavy smoker? (*A heavy smoker* refers to those who have smoked a total of over 100 cigarettes or have smoked over a period of 6 months and have been smoking	①はい Yes ②いいえ No

※医師の診断・治療のもとで服薬中の者を指す。  
\*Medication prescribed by a physician for treatment

FIGURE 1: The questionnaire form commonly used in health checkup examinations in Japan (Page 1 of 3).

This questionnaire form for health check-up examinees was created and published online by Ministry of Health, Labour and Welfare, Japan. <https://www.mhlw.go.jp/content/000793417.pdf>

Appendix B

分類 Category	No.	質問項目 Questions	回答 Answers
業務歴 Work history	9	over the past month.) これまでに、重量物の取扱いのある業務経験がありますか。 Have you ever handled heavy objects in your work?	①はい Yes ②いいえ No
	10	これまでに、粉塵の多い環境での業務経験がありますか。 Have you ever worked in an environment with lots of rocks, sand, or dust?	①はい Yes ②いいえ No
	11	これまでに、激しい振動を伴う業務経験がありますか。 Have you ever used a machine that vibrates at high speed in your work?	①はい Yes ②いいえ No
	12	これまでに、有害物質の取扱いのある業務経験がありますか。 Have you ever handled a hazardous substance in your work?	①はい Yes ②いいえ No
	13	これまでに、放射線の取扱いのある業務経験がありますか。 Have you ever handled radiation in your work?	①はい Yes ②いいえ No
	14	現在の職場では、どのような勤務体制で働いていますか。 What is your current work shift?	①常時日勤 Always on a day shift ②常時夜勤 Always on a night shift ③交替制（日勤と夜勤の両方あり） On an alternative shift (Both day and night shifts)
	15	現在の職場での、直近1ヶ月間の1日あたりの平均的な労働時間はどのぐらいですか。（昼食等の休憩時間を除き、時間外労働を含む） What are your average hours worked per day at your current workplace during the past month (excluding lunchtime and break time and including overtime)?	①6時間未満 Less than 6 hours ②6時間以上8時間未満 6 or more hours and less than 8 hours ③8時間以上10時間未満 8 or more hours and less than 10 hours ④10時間以上 10 or more hours
16	現在の職場での、直近1ヶ月間の1週間あたりの平均的な労働日数はどのぐらいですか。 What are your average days worked per week at your current workplace during the past month?	①3日間未満 Less than 3 days ②3日間以上5日間未満 3 or more days and less than 5 days ③5日間 5 days ④6日間以上 6 or more days	
体重増加 Body weight gain	17	20歳の時の体重から10kg以上増加していますか。 Have you gained over 10 kg from your weight at age 20?	①はい Yes ②いいえ No
身体活動 Physical activity	18	1回30分以上の軽く汗をかく運動を週2日以上、1年以上実施していますか。 Are you in a habit of doing exercise to sweat lightly for over 30 minutes a time, 2 times weekly, for over a year?	①はい Yes ②いいえ No
	19	日常生活において歩行又は同等の身体活動を1日1時間以上実施していますか。 In your daily life do you walk or do any equivalent amount of physical activity for more than one hour a day?	①はい Yes ②いいえ No
	20	ほぼ同じ年齢の同性と比較して歩く速度が速いですか。 Is your walking speed faster than the speed of those of your age and sex?	①はい Yes ②いいえ No
歯の状態 Teeth condition	21	食事をかんで食べる時の状態はどれにあてはまりますか。 Which of these best describes your condition while eating and chewing on food?	①何でもかんで食べることができる I can chew on anything. ②歯や歯ぐき、かみあわせなど気になる部分があり、かみにくいことがある Sometimes I have difficulty chewing due to problems of tooth, gum, or occlusion. ③ほとんどかめない I can hardly chew.
食習慣 Dietary habits	22	人と比較して食べる速度が速いですか。 Is your eating speed quicker than others?	①速い Quicker ②ふつう Normal ③遅い Slower
	23	就寝前の2時間以内に夕食をとることが週に3回以上ありますか。 Do you eat supper two hours before bedtime more than 3 times a week?	①はい Yes ②いいえ No

**FIGURE 2: The questionnaire form commonly used in health checkup examinations in Japan (Page 2 of 3).**

This questionnaire form for health check-up examinees was created and published online by Ministry of Health, Labour and Welfare, Japan. <https://www.mhlw.go.jp/content/000793417.pdf>

## Appendix C

分類 Category	No.	質問項目 Questions	回答 Answers
	24	朝昼夕の3食以外に間食や甘い飲み物を摂取していますか。 Do you eat snacks or drink sweet beverages between meals?	①毎日 Everyday ②時々 Sometimes ③ほとんど摂取しない Rarely eat
	25	朝食を抜くことが週に3回以上ありますか。 Do you skip breakfast more than 3 times a week?	①はい Yes ②いいえ No
飲酒の状況 Alcohol consumption	26	お酒(日本酒、焼酎、ビール、洋酒など)はどの位の頻度で飲みますか。 How often do you drink? (sake, shochu, beer, wine, whisky, or brandy, etc.)	①毎日 Everyday ②時々 Sometimes ③ほとんど飲まない(飲めない) Rarely drink (Cannot drink)
	27	飲酒日の1日当たりの飲酒量はどの位ですか。 日本酒1合(180ml)の目安: ビール中瓶1本(約500ml)、焼酎25度(110ml)、ウイスキーダブル一杯(60ml)、ワイン2杯(240ml) How much do you drink per day? Sake (180 ml), beer (500 ml), Shochu 25% (110 ml), double whisky (60 ml), two glasses of wine (240 ml)	①1合未満 Less than 180 ml ②1~2合未満 180-360 ml ③2~3合未満 360-540 ml ④3合以上 More than 540 ml
休養 Sleeping	28	睡眠で休養が十分とれていますか。 Do you sleep well and enough?	①はい Yes ②いいえ No
生活習慣改善意向 Disposition to improve life habits	29	運動や食生活等の生活習慣を改善しようと思っていますか。 Do you want to improve your life habits of eating and exercising?	①改善するつもりはない Don't want to ②改善するつもりである(概ね6か月以内) Do want to (within 6 months) ③近いうちに(概ね1か月以内)改善するつもりであり、少しずつ始めている Want to improve in near future (within a month) and began to start ④既に改善に取り組んでいる(6か月未満) Already trying to improve (less than 6 months) ⑤既に改善に取り組んでいる(6か月以上) Already trying to improve (over 6 months)
	30	生活習慣の改善について保健指導(個人への指導)を受ける機会があれば、利用しますか。 Do you want to use the opportunity of health instructions for improvement of your life habits?	①はい Yes ②いいえ No
その他 Other	31	何か健康について相談したいことがありますか。 Do you have any health issue on which you need consultation?	①はい Yes ②いいえ No

**FIGURE 3: The questionnaire form commonly used in health checkup examinations in Japan (Page 3 of 3).**

This questionnaire form for health check-up examinees was created and published online by Ministry of Health, Labour and Welfare, Japan. <https://www.mhlw.go.jp/content/000793417.pdf>

## Appendix D

Frequency of health check-up examinations between 2014 and 2019	Males				Females			
	n	Precontemplation	Contemplation/ preparation	Action/ maintenance	n	Precontemplation	Contemplation/ preparation	Action/ maintenance
	Average of weight gain* (SD) (kg)				Average of weight gain* (SD) (kg)			
All								
twice	696	1.28 (4.41)	1.40 (4.84)	1.15 (4.41)	637	0.64 (4.14)	1.29 (4.05)	1.44 (4.17)
3 to 4 times	4391	1.45 (4.60)	1.16 (4.84)	0.95 (4.33)	4591	0.86 (3.79)	1.04 (3.91)	0.86 (3.61)
5 to 6 times	78991	1.27 (4.25)	0.94 (4.43)	0.73 (4.17)	46190	0.87 (3.53)	0.83 (3.61)	0.66 (3.47)
< 65 years old								
twice	642	1.56 (4.35)	1.51 (4.80)	1.32 (4.47)	596	0.73 (4.25)	1.33 (4.09)	1.48 (4.15)
3 to 4 times	4039	1.58 (4.70)	1.26 (4.87)	1.14 (4.47)	4259	1.10 (3.70)	1.10 (3.93)	1.09 (3.64)
5 to 6 times	73289	1.37 (4.28)	1.00 (4.47)	0.91 (4.30)	41856	1.04 (3.49)	0.90 (3.63)	0.83 (3.56)
≥ 65 years old								
twice	54	-1.34 (4.23)	-0.65 (3.18)	-0.22 (3.24)	41	-0.19 (3.16)	0.34 (2.67)	1.17 (4.43)
3 to 4 times	352	-0.04 (2.90)	-0.73 (3.60)	-0.18 (3.15)	332	-1.38 (3.84)	-0.45 (3.11)	-0.60 (3.00)
5 to 6 times	5702	-0.50 (3.18)	-0.49 (3.10)	-0.34 (3.02)	4334	-0.58 (3.53)	-0.43 (3.03)	-0.24 (2.79)

**TABLE 4: Weight gain by sex, age groups, and the categories of behavioral change stages in the transtheoretical model.**

\*Weight gain is calculated from the weight difference between 2014 and 2019.

SD, standard deviation

## Additional Information

### Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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