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Research Article

Influence of Specific Health Guidance on the Consultation Rate of Metabolic-Related Diseases

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In Japan, national health expenditure is increasing each year. In particular, medical care costs for the elderly is growing at the rate of about 9% annually alongside the rapid increase of the aging population. In Japan, the specific health checkup and specific health guidance were implemented in 2008 to reduce medical costs in the medium to long term by preventing metabolic syndrome. To evaluate the influence of Specific Health Guidance on medical costs for metabolic-related or other diseases, we conducted propensity score matching and compared between those who received the Health Guidance and those who did not. The two groups were extracted from those with zero outpatient medical expenses for the five months prior to the checkup. The following were selected as variables for matching: gender, age, BMI, abdominal circumference, systolic blood pressure, HbA1c, total cholesterol, urinary protein, smoking/nonsmoking, hoping/not hoping for Health Guidance, and willing/not willing to improve one's lifestyle habits. Finally, 50 one-to-one matches were performed between the intervention and control groups. The results of the Tobit regression analysis showed that Health Guidance significantly lowered metabolic-related medical expenses for the 26 months. However, for other diseases, no significant difference for medical expenses was evident between the two groups. The consultation rate of the intervention group after 12 months was 28% and 46% for the control group. The results suggest that the Specific Health Guidance in Japan reduced outpatient consultation for metabolic-related diseases.

1. Introduction

In Japan, national health expenditure is increasing each year. During fiscal year 1999, national health expenditure exceeded 30 trillion Japanese yen (JPY) for the first time and is currently almost 40 trillion JPY. Furthermore, the ratio of national health expenditure to gross domestic product now totals 8.3% [1]. In particular, medical care costs for the elderly are increasing at a rate of approximately 9% annually alongside the rapidly increasing aging population. A comparison of the medical examination fee per person indicates that the fee for the elderly is five times greater than that for the nonelderly [2]. Considering this, it is necessary that we continue to promote the improvement and management of lifelong health and offer adequate, efficient medical care for the elderly. At the same time, evidence-based preventive measures are needed to control the burden on society due to rapidly increasing medical expenditure. In 2008, the Japanese Ministry of Health, Labour and Welfare implemented a standard medical checkup program to identify persons at a high risk of metabolic syndrome as part of a series of measures implemented to achieve appropriate levels of medical expenditure.

This medical checkup program is intended to help prevent lifestyle-related chronic conditions, with a focus on preventing metabolic syndrome. All health insurers in Japan including the Employee's Health Insurance are required to provide these services, which are composed of specific medical checkups and specific healthcare guidance.

The checkup comprises 28 items including an annual laboratory test, physical examination to evaluate metabolic syndrome risk factors, and a questionnaire consisting of 22 items (Appendix).

The results of these examinations are used to identify those needing specific healthcare guidance by assigning them to three assistance levels (information service only,

Table 1: Support type after the checkup.

Support type	NHI insured who went for the checkup						NHI insured who received the first intervention					
	Men		Women		Total		Men		Women		Total	
Information Service Only	681		1814		2495							
Motivational Support	190	(97)	207	(93)	397	(190)	18	(17)	25	(20)	43	(37)
Active Support	359	(29)	162	(139)	521	(168)	14	(12)	5	(2)	19	(14)

Number of people whose outpatient score for metabolic-related diseases was zero for the five months before the checkup was given in parentheses.

motivational support, and active support). These levels correspond to their risk level and focus on the extent of visceral fat buildup and numerous other risk factors. In addition, when notified of the examination results, those who have undergone the specific medical checkup are given information adapted to their individual needs based on the examination results. Specific healthcare guidance provides assistance to improve lifestyle such as diet and exercise habits according to lifestyle disease risks. In addition, both motivational and active support include initial counseling and a final evaluation after six months.

Furthermore, the checkup and guidance programs in Japan are an approach to reduce medical expenses in the medium or long term through interventions focusing on lifestyle habits. However, it is difficult to quantitatively estimate the influence of the intervention on medical expenses. In this study, to evaluate the influence of specific health guidance on the medical cost of metabolic-related or other diseases, we performed propensity score matching and compared those who received health guidance with those who did not.

2. Method

2.1. Study Population. The checkup and guidance programs in this study are provided to insured members of the community and dependents aged 40 to 65 years (including persons reaching this age range during the fiscal year).

Table 1 shows the type of support for those insured who underwent the checkup during the period of May–December, 2012, in Mishima City, Shizuoka Prefecture. The targets of health guidance in Japan are classified into three groups according to their risk: information service only, motivational support, and active support. In total, 918 of 3,413 people were classified as needing motivational support or active support, and these were targeted as needing health guidance. Of the 918 people, 62 received health guidance.

Of these 62 people, 51, whose outpatient score for metabolic-related diseases was zero for the five months before the checkup, were considered the intervention group in this study (hereafter "Group I") (Figure 1).

2.2. Propensity Score Matching. Propensity score matching is prevalent in observational studies as a method capable of evaluating causal relationships [3, 4]. This analysis method enables adjusting covariates from observation data by means of a propensity score when a randomized controlled trial is difficult in clinical medicine or epidemiology.

Furthermore, the method is employed to reduce the impact of treatment selection bias in estimating treatment effects using observational data. The propensity score is a subject's probability of treatment on observed baseline covariates. Matching based on this propensity score ensures that treated and untreated subjects have similar distributions of observed baseline covariates.

In this study, the propensity score is the probability of receiving health guidance, which can be estimated based on the checkup and questionnaire (Appendix). When comparing the intervention group (Group I) and control group (hereafter "Group C") with similar propensity scores, it is considered similar to a randomized controlled trial in observation studies. Thus, we examined the influence of specific health guidance on outpatient consultation rates and the medical expenses for metabolic-related diseases through propensity score matching. For the 358 people, the probability of taking health guidance was calculated using the propensity score. From the 28 items in the annual laboratory test, physical examination to evaluate metabolic syndrome risk factors, and 22 items of the questionnaire, we selected the optimal explanatory variables (covariate) that maximize the area under the curve (AUC) obtained from the calculated propensity score and receiver operating characteristic (ROC) curve.

One-to-One Matching. One-to-one matching (nearest neighbor algorithm) was performed under the following two conditions. (i) No overlap, no replacement: targets with counterparts shall be excluded. (ii) Common support: selection shall be made from the overlapping area of the propensity score. Finally, 50 one-to-one matches were performed between the intervention and control groups (Figure 1). One-to-one matching was conducted using Stata MP13 (Stata command: psmatch2).

Based on the calculated propensity score and ROC curve, the following elements were selected as explanatory variables (covariates): gender, age, classification (motivational support = 0, active support = 1), number of checkup(s) until the previous year (0–3 times), BMI, systolic blood pressure, HbA1c, abdominal circumference (all these were normalized), exercise habits, hoping/not hoping to receive health guidance, willingness to improve one's lifestyle habits, and drinks/does not drink alcohol (all these were denoted as Yes =1, No = 0). The AUC (ratio of the area below the ROC curve) was 0.683 (Figure 2).

As a result, an optimal propensity score for estimating the probability of receiving health guidance was calculated

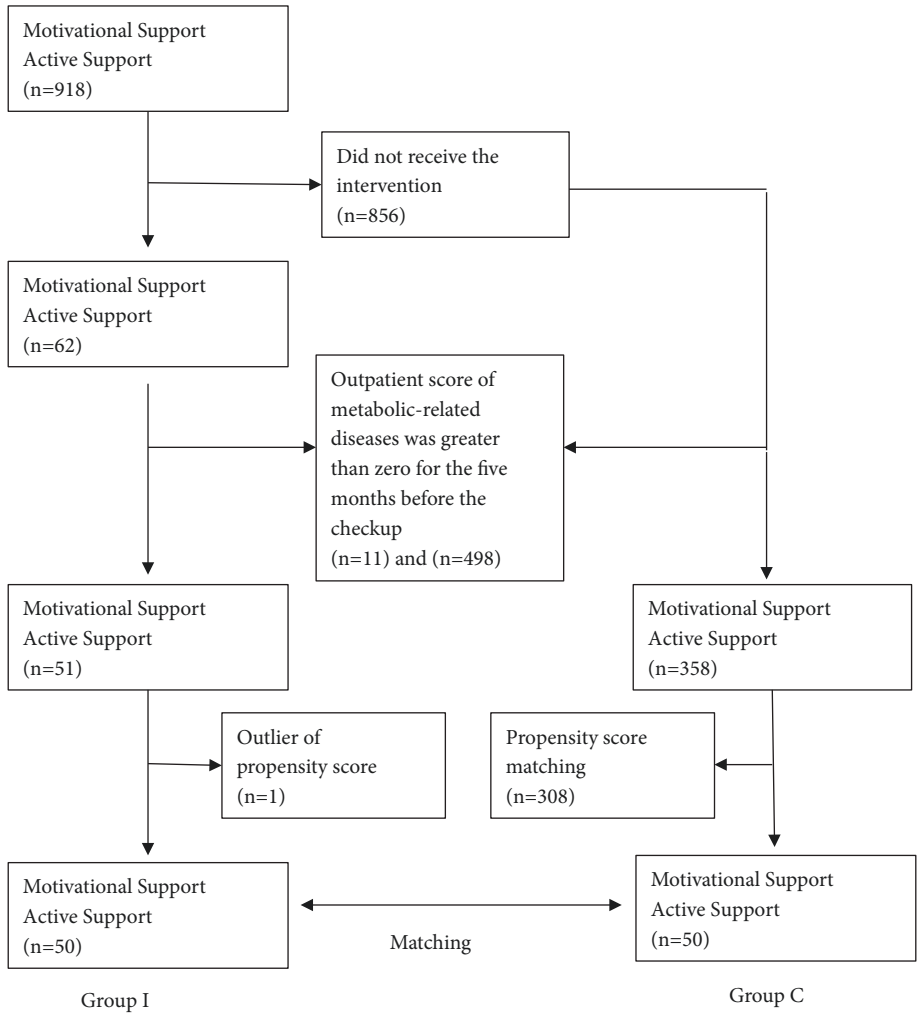

Figure 1: Sampling flow diagram.

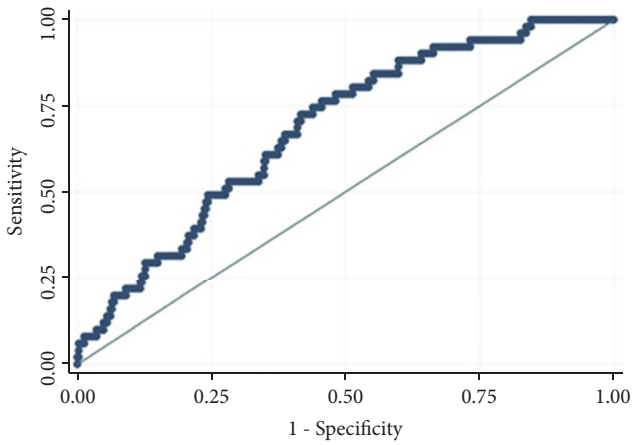

Figure 2: ROC curve for propensity score matching.

(Table 2). One of the 51 health guidance recipients was excluded, because of a too distant propensity score, and 50 pairs (100 people) from Groups I and C were selected. The final study population consisted of 61 males (61%) and 39 females (39%) with a mean age of 56.3 ± 8.0 (range, 39–64) years. Table 3 shows the normalized average value of the two groups.

2.3. Data Analysis. The propensity score was employed to reduce bias in the linear regression model as independent variables [5]. We performed a Tobit regression analysis, setting received/did not receive health guidance and the propensity score as the explanatory variable and medical expenses as the objective variable. While many people had zero medical expenses (zero section), the Tobit regression had to be conducted rather than the ordinary linear regression [6].

Regarding target expenses, we analyzed outpatient/dispensing receipts only (hospitalization/dentistry receipts were excluded) for the 26 months (receipts dated from January 2013 to February 2015). Metabolic-related diseases were defined as E1 (diabetes), E7 (hyperlipidemia, etc.), and I1 (hypertension) according to the ICD-10 codes. Suspected diseases were also included. For the dispensing receipts, only drug costs were considered, and technical fees such as compounding fees were excluded. We used the

Table 2: Results of propensity score matching.

	probability	Group I		Group C		Total
		observed value	predicted value	observed value	predicted value	
1	0.043-0.063	0	1.2	36	34.8	36
2	0.063-0.085	3	1.9	33	34.1	36
3	0.085-0.106	2	2.7	34	33.3	36
4	0.106-0.129	3	3.4	33	32.6	36
5	0.129-0.156	4	4.1	31	30.9	35
6	0.156-0.185	8	5.1	28	30.9	36
7	0.185-0.217	6	6.1	30	29.9	36
8	0.217-0.258	9	7.3	27	28.7	36
9	0.258-0.409	6	8.6	30	27.4	36
10	0.409-1.000	10	10.6	25	24.4	35
	N	51		307		358

Hosmer-Lemeshow chi2(8)=5.61
Prob > $\chi 2$ 0.691.

Table 3: Normalized average value of the two groups.

	Normalized average value		Std. Mean Difference
	Group I	Group C	
Age	-0.26	-0.30	0.04
Gender	0.57	0.67	-0.22
Support type	0.27	0.50	-0.48
Number of prior checkups	1.04	1.39	-0.30
BMI	-0.02	-0.14	0.12
Systolic blood pressure	-0.30	-0.10	-0.20
HbA1c	-0.52	-0.39	-0.15
Abdominal circumference	-0.02	-0.12	0.10
Exercise habits	0.31	0.27	0.10
Hoping/not hoping for guidance	0.61	0.53	0.16
Willingness to improve one's lifestyle habits	0.90	0.82	0.24
Drinks/does not drink alcohol	0.55	0.58	-0.06

Japan Standard Commodity Classification (JSCC) to classify the drug costs. Among the JSCC codes, 21 (circulatory preparation), 396 (diabetes drug), and 2496 (insulin preparation) were defined as metabolic-related medications.

Medical expenses increase when those insured consult medical facilities. Therefore, in addition to comparing metabolic-related medical expenses, we also compared the outpatient consultation ratio for metabolic-related diseases.

These analyses were conducted using Stata MP13 (Lightstone, Co. Ltd., Tokyo, Japan) and SPSS23 (IBM Co. Ltd., Tokyo, Japan).

2.4. Ethical Considerations. This survey was approved by the Ethics Committee of the National Institute of Public Health (NIPH-IBRA #12137) and City Council Meeting in Mishima City. All methods were conducted in accordance with the Ethical Guidelines for Epidemiological Research [7], Guidelines for the Provision of Database for National Health Insurance Claim / Specific Medical Checkup / Specific Health Guidance [8], and Security Guidelines for Health Information Systems [9]. Since the purpose of the specific medical checkup and specific health guidance in Japan was not for the research, but for the National Public Health Service, informed consent to participate in the study was not obtained. However, for the purpose of the Medical Care Expenditure Regulation Plan, secondary use of the anonymized limited database was approved for the analysis in accordance with the guidelines [8] based on the law in Japan.

3. Results

3.1. One-to-One Matching. Table 4 compares the two groups' medical expenses for metabolic-related and other diseases for 26 months. The metabolic-related medical expenses for Group I for the 26 months were 12,530 JPY, whereas those of the matched Group C were 44,047 JPY. This is a difference of 31,517 JPY for the 26 months between receiving/not receiving health guidance (95% confidence interval: 9,720–53,314 JPY, p value: 0.008). As such, health guidance significantly lowered metabolic-related medical expenses by 31,517 JPY (71.55%) for the 26 months. However, for other diseases, there was

Table 4: Comparison of medical expenses for metabolic-related and other diseases for 26 months.

	Medical expenses for metabolic-related diseases		Medical expenses for other diseases	
Group C	44,047	p=0.008	159,413	p=0.800
Group I	12,530		149,277	
				(JPY)
	1 USD is equivalent to about 110 JPY			

Table 5: Results of the Tobit regression with metabolic-related medical expenses set as an objective variable.

	Coef.	P > |t|	95% CI	
Receiving/Not receiving guidance	-57,794	0.012	-103,068	-12,520
Propensity score	-160,873	0.085	-343,874	22,128
const.	25,655	0.083	-3,366	54,675
/sigma	126,544	140,253		

Table 6: Results of the Tobit regression with other medical expenses set as an objective variable.

	Coef.	P > |t|	95%CI	
Receiving/Not receiving guidance	18,570	0.663	-65,059	102,198
Propensity score	-160,125	0.377	-516,261	196,012
const.	149,460	0	92,662	206,259
/sigma	270,144	291,594		

no significant difference between the two groups for medical expenses.

3.2. Tobit Regression Analysis. Tables 5 and 6 provide the results of the Tobit regression. Metabolic-related and other medical expenses were set as the objective variables. The results indicate a difference of 57,794 JPY for the 26 months for receiving/not receiving health guidance (95% confidence interval: 12,520–103,067 JPY; p value: 0.012) (Table 5). No significant difference was observed for other medical expenses.

3.3. Outpatient Consultation Ratio for Metabolic-Related Diseases. Figure 3 shows the transition of the cumulative numbers of zero metabolic-related outpatient medical expenses after the checkup. As the observation period gets longer, the ratio of zero metabolic-related medical expenses decreases. However, Group I's ratio of zero metabolic-related medical expenses is consistently higher than that of Group C. The consultation rate of the intervention group after the 12 months was 28%, and that of the control group was 46%.

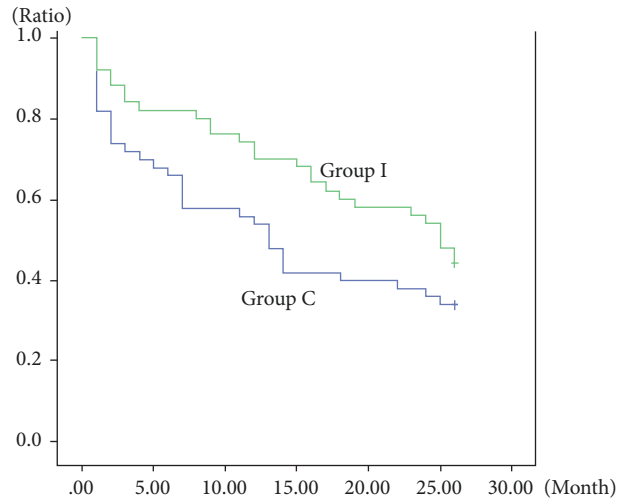

Figure 3: Outpatient consultation ratio of the metabolic-related diseases in Groups I and C. (Kaplan-Meier Curve).

4. Discussion

Similar health programs have been reported in other countries. Griffin et al. (2014) reported a randomized controlled trial (RCT) in checkup programs in the UK. An explanatory RCT was conducted in 34 general practices in Eastern England. For patients with recently diagnosed type 2 diabetes receiving intensive treatment in primary care in the UK, a facilitator-led, individually tailored behavior change intervention did not improve objectively measured health behaviors or cardiovascular risk factors over a period of one year [10].

In Japan, the specific medical checkup and specific health guidance were implemented from 2008 to reduce medical costs in the medium to long term by preventing metabolic syndrome. The plan is already in its second phase [11]. A database of the National Health Insurance Claims as well as of information pertaining to the specific medical checkup and specific health guidance in Japan (hereafter "database") was established to evaluate the influence of these on medical costs. It is used in the stochastic method of determining

Table 7: The specific health checkups standard questionnaire.

	Questions	Answer choices
Q1-3	Are you currently taking the following medications?	Yes / No
	(1) a medicine to lower blood pressure	Yes / No
	(2) insulin injections or a medicine to lower blood glucose	Yes / No
	(3) a medicine to lower cholesterol	Yes / No
Q4	Have you ever been told by a doctor that you have stroke (e.g., cerebral hemorrhage, cerebral infarction) or have you ever received treatment for stroke?	Yes / No
Q5	Have you ever been told by a doctor that you have heart disease (e.g., angina, myocardial infarction) or have you ever received treatment for heart disease?	Yes / No
Q6	Have you ever been told by a doctor that you have chronic renal failure or have you ever received treatment for chronic renal failure (dialysis)?	Yes / No
Q7	Have you ever been told by a doctor that you have anemia?	Yes / No
Q8	Are you a current regular smoker? (※A "current regular smoker" is a person who has smoked a total of 100 or more cigarettes or smoked for 6 months or longer and has been smoking for the last 1 month.)	Yes / No
Q9	Have you gained ≥10 kg since you were 20 years old?	Yes / No
Q10	Have you been exercising for 30 minutes or more each at an intensity that causes a slight sweat, 2 days or more every week, for at least 1 year?	Yes / No
Q11	Have you been exercising such as walking or equivalent more than 1 hour everyday in your daily life?	Yes / No
Q12	Do you walk faster than people of your age and sex?	Yes / No
Q13	Have you had a weight gain or loss of ≥3 kg over the last year?	Yes / No
Q14	How fast do you eat compared to others?	Faster / Normal / Slower
Q15	Do you have an evening meal within 2 hours before going to bed 3 days or more every week?	Yes / No
Q16	Do you have snacks (nights meals in addition to 3 daily meals) after the evening meal 3 days or more every week?	Yes / No
Q17	Do you skip breakfast 3 days or more per week?	Yes / No
Q18	How often do you drink alcohol (sake, shochu [distilled spirits], beer, liquor, etc.)?	Everyday / Sometimes / Rarely (can't drink)
Q19	How much do you drink a day, in terms of glasses of refined sake? (A glass [180 mL] of refined sake is equivalent to a medium bottle [500 mL] of beer, 80 mL of shochu (alcohol content 35 percent), a glass [double, 60 mL] of whiskey, and 2 glasses [240 mL] of wine.)	① <1 ② ≥1 and <2 ③ ≥2 and <3 ④ ≥3
Q20	Do you feel refreshed after a night's sleep?	Yes / No
Q21	Are you going to start or have you started lifestyle modifications (e.g., increase physical activity, improve dietary habit)?	① No plan to improve. ② I'm going to start in the future (e.g., within 6 months). ③ I'm going to start soon (e.g., in a month), or I have just started some of them. ④ I already started (<6 months ago). ⑤ I already started (≥6 months ago).
Q22	Are you willing to have Health Guidance about lifestyle modifications if the opportunity arises?	Yes / No

prefectural medical costs because the database indicates the difference in the total medical costs per year between those classified as suffering from metabolic syndrome and those who do not [12]. However, this estimation has the following limitations. First, the matching rate between the checkup data in the database and that of receipts is low and not constant in each gender or age class [13]. Specifically, the rate is less than 10% for males aged less than 65 years, the main target of the health guidance program [14]. Second, the medical costs in the database are not limited to metabolic-related diseases and include all types of diseases (while it does not include dentistry expenses, it does include hospital charges).

Furthermore, to evaluate the influence of interventions such as the health guidance program on medical costs, it is not sufficient to simply compare those with metabolic syndrome with those who do not suffer from it. The results of the meta-analysis of the NHI Health-up Model Project [15] implemented before the checkup or guidance programs and those of the Health Insurance Society through propensity score matching did not explicitly show the influence of health guidance on medical expenses [16].

Although the study comprised few respondents, through the Tobit regression analysis, this survey showed that health guidance tends to decrease metabolic-related medical expenses. Furthermore, the Kaplan-Meier method indicated that undergoing the guidance reduced consultations for metabolic-related diseases to a mild degree. In Japan, the specific medical checkup and specific health guidance may have had some influence on medical expenses pertaining to metabolic-related diseases.

5. Conclusion

The results of this study suggested that in Japan, the specific health guidance program reduced outpatient consultation for metabolic-related diseases.

Appendix

See Table 7.

Data Availability

To protect participants' anonymity, data will not be shared unless for administrative purposes.

Conflicts of Interest

All authors declare no conflicts of interest associated with this manuscript.

Authors' Contributions

Yoh Tamaki, Etsuji Okamoto, Yoshimune Hiratsuka, and Toshiro Kumakawa made substantial contributions to the conceptualization, data acquisition, study design, statistical analysis, interpretation of results, and drafting of the manuscript.

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