

Original

Needs survey on the priority given to periodical medical examination items among occupational physicians in Japan

Naoto Ito¹, Tomohisa Nagata², Masayuki Tatemichi³, Toru Takebayashi⁴ and Koji Mori²

¹Occupational Health Training Center, University of Occupational and Environmental Health, Japan, ²Department of Occupational Health Practice and Management, Institute of Industrial Ecological Science, University of Occupational and Environmental Health, Japan, ³Department of Preventive Medicine, Tokai University, School of Medicine, Japan and ⁴Department of Preventive Medicine and Public Health, School of Medicine, Keio University, Japan

Abstract: Objectives: To clarify the priority given to periodical medical examination items among occupational physicians in Japan. **Methods:** Sixty-two occupational physicians who participated in this study selected statutory and non-statutory items within two types of budget plans: one lower (8,500 yen) than the total fee of statutory medical examinations (9,250 and 11,290 yen), and the other higher (12,000 yen) than the total fee. Medical fee points were used to set the cost of each medical examination item. A three round Delphi method was used from May to July 2016 to clarify the consensus opinion of occupational physicians. **Results:** The statutory items (selection rate: between 66 and 100%), except for waist circumference (15%) and sputum examination (0%), and serum creatinine (58%, non-statutory item) were included in the smaller budget plan (8,500 yen). In the larger budget plan (12,000 yen), the statutory items (selection rate: between 92 and 100%), except for waist circumference (39%) and sputum examination (0%), and some non-statutory items, namely serum creatinine (95%), leukocytes (92%), uric acid (89%), and fecal occult blood reaction (81%), had a selection rate over 80%. In addition, statutory items with higher accuracy were preferred, which included the following: air conduction pure-tone audiometry (92%), imaging diagnosis of thoracic X-ray examinations by a specialist (97%), glycated hemoglobin levels (98%), and electrocardiogram assessment by a specialist (100%). **Conclusion:** The statutory items, except for waist circumference and sputum examination, and some of the non-statutory items (e.g., serum

creatinine) were given higher priority among occupational physicians in Japan.

(J Occup Health 2018; 60: 502-514)

doi: 10.1539/joh.2017-0328-OA

©Article author(s). This is an Open Access journal distributed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. To view the details of this license, please visit (<https://creativecommons.org/licenses/by-nc-sa/4.0/>).

Key words: Japan, Occupational health physicians, Physical examination

Background and objectives

In Japan, occupational medical examinations were introduced by the Factory Act in 1911, which aimed to control tuberculosis. As part of the 1972 Industrial Safety and Health Act, blood pressure and urinalysis were added to the medical examination items, and periodical medical examinations were started for the prevention of work-related diseases (e.g., brain and heart diseases). In 2008, social demands such as optimization of medical expenses and harmonization with specific health checkups as countermeasures against metabolic syndrome led to changes in the included items. By law, all workers undergo the periodical medical examination with the same included items, regardless of their age, sex, and occupation.

Of the statutory items in the current medical examination, blood pressure, blood glucose, and blood lipids are the items commonly used in domestic and international clinical practice guidelines¹⁻⁴ as risk factors for brain and heart diseases and death. Some reports state that the performance of medical examinations does not reduce mortality⁵⁻⁷. However, employers have legal obligations to

Received December 28, 2017; Accepted July 16, 2018

Published online in J-STAGE September 20, 2018

Correspondence to: N. Ito, Occupational Health Training Center, University of Occupational and Environmental Health, 1-1 Iseigaoka, Yahatanishi-ku, Kitakyusyu, 807-8555, Japan (e-mail: naotoito@med.uoe-h-u.ac.jp)

implement periodic medical examinations, as well as measures for following-up on an employee's fitness for work⁸⁾. Thus, when examining the utility of medical examination items, in addition to medical evidence such as the early detection of diseases and reduction in mortality, it is also important to take into consideration the objectives of occupational health (e.g., fulfillment of the duty to care for employees, and to establish and maintain a work environment that conforms to the physiological and psychological competence of the workers⁹⁾).

The results of focus group interviews¹⁰⁾ conducted among occupational physicians as a preliminary survey in this study showed that in addition to the statutory items, the non-statutory items added by companies to the medical examination also have utility in occupational health, indicating the efforts to optimally utilize each item¹¹⁾.

Companies need to conduct medical examinations within a limited budget, and must consider the medical utility of each test item, as well as performing a comprehensive evaluation of the position and priority of all test items. Such evaluations are also necessary when reviewing statutory medical examination items, and when each company adds non-statutory items.

Thus, to clarify the order of priority of the periodical medical examination items from the perspective of occupational health, a survey assessing the priority of the items within the budget was performed among occupational physicians who were involved in the selection of non-statutory items and the follow-up of medical examinations in companies.

Methods

This study had two steps. First, questionnaires were developed to investigate the setting of examination fees for the medical examination items, the budget for medical examinations, and the preliminary survey. Second, the survey was administered to occupational physicians to assess medical item needs.

First step: Development of questionnaires

1. Setting examination fees for the medical examination items

Based on medical fee points¹²⁾, which is the calculation standard of medical fees in medical insurance in Japan, the cost of each item was determined as shown in Table 1. Participating occupational physicians were able to select these items as part of the medical examination.

(1) Basic tests

In this study, the medical examination items with a fee equivalent to the "first visit fee (A000)" of 2,820 yen in the medical fee points were defined as basic tests. Those items were used for the investigation of anamnesis and work history, examination of the presence or absence of subjective and objective symptoms, and examination of

height, weight, and blood pressure in the periodical medical examination items.

According to a study, waist circumference should be considered as a diagnostic item, rather than a mandatory item, for the diagnosis of metabolic syndrome¹³⁾. Thus, to examine the priority given to medical examination items, this study sought to define waist circumference as a separate item rather than a basic test item. In addition, because waist circumference was not listed in the medical fee points, and the examination fees for the other items were between 110 and 180 yen per item, the examination fee for waist circumference was set at 100 yen, which is somewhat lower and easier to calculate than the other fees. Likewise, the examinations of hearing (hearing test by interview) and body fat percentage, which seem to be included in the basic items, were not listed in the medical fee points. Thus, the examination fee for these items was set at 100 yen.

(2) Examination of eyesight

The fee for the examination of eyesight was set at 690 yen, which is equal to that of the "corrected visual acuity test (D263)" administered during "ophthalmological examination."

(3) Examination of hearing

An audiometer is commonly used in the examination of hearing. The fee for the examination of hearing was set at 1,100 yen, which is equal to the medical fee points for "air conduction pure-tone audiometry," "brief hearing test," and "subjective audiometry (D244)." Physicians choose the method of examination based on conversations in a medical interview for most workers under the age of 45 years. Therefore, audiometry and a hearing test by interview (100 yen) were made available for the examination of hearing.

In this study, some items had two test options: brief examination (with a lower cost) and detailed examination (with a higher cost).

(4) Thoracic X-ray examination

The accuracy of thoracic X-rays varies considerably, and the effectiveness of thoracic X-rays is important for quality control¹⁴⁾. Imaging diagnosis by a specialist is one of the items in the checklist for investigating industrial health service functions¹⁵⁾. Companies can choose certified facilities that provide thoracic X-ray examination imaging by a specialist. Thus, two fees were set for thoracic X-ray examination: one with imaging diagnosis by a radiologist, and the other with imaging diagnosis by other physicians.

The cost of a brief examination, such as undergoing a diagnostic examination by a non-radiologist, was 2,100 yen, calculated as the sum of 850 yen for "Head, chest, abdomen or spine" in the "X-ray diagnosis fee (imaging diagnosis [E001])," 680 yen for "Digital imaging" in "X-ray diagnosis fee imaging [E002])," and 570 yen for "Simple X-ray" in general rule four of the X-ray diagno-

Table 1. List of examination fees for the statutory medical examination items and non-statutory items

(a) Statutory items

Test items	Examination fee (yen)	Statutory minimum (9,250 yen)	Statutory maximum (11,290 yen)
Basic tests	2,820	○	○
-Investigation of anamnesis and work history			
-Examination for the presence of subjective and objective symptoms			
-Examination of height and weight			
-Blood pressure measurement			
Waist circumference	100	○	○
Examination of eyesight	690	○	○
Examination of hearing			
Hearing test by interview (brief examination)	100		
Air conduction pure-tone audiometry (detailed examination)	1,100	○	○
Thoracic X-ray examination			
Imaging diagnosis by a non-specialist (brief examination)	2,100	○	
Imaging diagnosis by a specialist (detailed examination)	2,950		○
Sputum examination	320		
Anemia examination; Hemoglobin content and erythrocyte count	80	○	○
Examination of hepatic function			
AST	170	○	○
ALT	170	○	○
γ -GTP	110	○	○
Examination of blood lipid levels			
HDL cholesterol	170	○	○
LDL cholesterol	180	○	○
Triglycerides	110	○	○
Examination of blood sugar level			
Blood glucose (brief examination)	110	○	○
HbA1c (detailed examination)	490		○
Urine analysis: Examination of the presence or absence of glucose and protein in urine	40	○	○
Electrocardiogram			
Automatic determination only (brief examination)	1,300	○	
Assessment by a specialist (detailed examination)	2,000		○

sis fee.

According to the statement that “imaging diagnosis of film etc. taken in other medical institutions, each calculated by the imaging area and imaging method” in the “Notice of X-ray diagnosis fee (E001 imaging diagnosis),” 850 yen was added for an imaging diagnosis by a radiologist (i.e., a detailed examination), for a total fee of 2,950 yen.

(5) Blood tests

The blood tests included in the statutory medical examination items consisted of an anemia examination (hemoglobin content and erythrocyte count), examination of hepatic function (aspartate transaminase [AST], alanine transaminase [ALT], and γ -glutamyl transpeptidase [γ -GTP]), examination of blood lipid levels (low-density

lipoprotein [LDL] cholesterol, high-density lipoprotein [HDL] cholesterol, and serum triglycerides), and examination of blood sugar level.

Regarding the examination fees, the test items were listed by medical fee points in “specimen test fee (hematological characteristics and function tests [D005], blood chemistry tests [D007]).” For the examination of blood sugar levels, a detailed examination and brief examination were defined as a HbA1c test (490 yen) and a blood glucose test (170 yen), respectively.

According to the “general peripheral blood test” of the “specimen test fee (hematological characteristics and function tests [D005]),” the anemia examination (hemoglobin content and erythrocyte count) was 210 yen in total, including white blood cells, hematocrit levels, and

Table 1. List of examination fees for the statutory medical examination items and non-statutory items (continued)

(b) Non-statutory items (30 items)		
Test items	Test fee (yen)	Questionnaire items (15 items)
Body fat percentage	100	○
Blood tests		
White blood cell count	40	○
Platelet count	40	○
Hematocrit levels	40	○
Serum creatinine	110	○
Urea nitrogen	110	○
Uric acid	110	○
Total cholesterol	170	○
Total bilirubin	110	○
ALP	110	○
PT	180	○
APTT	290	○
Potassium	110	○
Blood ketone bodies	110	
Fe	110	
Ferritin	1,160	
CK	110	
Ammonia	500	
Blood gas analysis	1,460	
Peripheral blood picture (microscopic examination)	250	
Bleeding time	150	
FDP	800	
D-dimer semi-quantitative test	1,370	
Urine analysis		
Urine occult blood test	20	○
Urine specific gravity	20	
Urinary ketone bodies	20	
Urine specific gravity	20	
Dipstick test of urine leukocyte esterase	20	
Fecal occult blood reaction	90	○
Ultrasound		
Chest and abdominal ultrasound	5,300	
Head and neck ultrasound	3,500	

AST- aspartate transaminase, ALT- alanine transaminase, γ -GTP- γ -glutamyl transpeptidase, HDL- high-density lipoprotein, LDL- low-density lipoprotein, HbA1c- glycated hemoglobin, ALP- alkaline phosphatase, CK- creatinine kinase, PT- prothrombin time, APTT- activated partial thromboplastin time, FDP- fibrinogen degradation product. Circles indicate that the item was available for selection.

platelet count in the non-statutory items. Thus, in this study, the fee for these five items were set at 40 yen each, while the fee for anemia examination (hemoglobin content and erythrocyte count) was set at 80 yen.

(6) Urinalysis

A total of 13 items, including urine specific gravity and urine occult blood reaction, a non-statutory item, are listed in the examination of the presence or absence of glucose and protein in urine. As the fee for urine qualita-

tive/semi-quantitative tests (D000) is 260 yen, the fee for each item was set at 20 yen.

(7) Examination by electrocardiogram

It is recommended that physicians with sufficient knowledge and experience in electrocardiography provide an interpretation and a diagnosis of ECG waveforms¹⁶⁾. Assessment by a specialist is included in the checklists¹⁵⁾. Companies can choose certified facilities that provide ECG assessment by a specialist. Accordingly, two types

of examinations were set: automatic assessment with ECG testing equipment, or assessment by a cardiologist, excluding other types of physicians.

According to “(1) At least 12 leads including unipolar limb leads and chest lead” in “examination by electrocardiogram [D208],” the fee for examination with automatic assessment (i.e., brief examination) was set at 1,300 yen. In addition, the annotation of this item states that “when the above-described ECG is assessed in a medical institution other than the said medical insurance institution, the fee would be 700 yen per assessment.” Thus, when a cardiologist provides the assessment of the ECG waveforms, an extra fee of 700 yen is added, for a total fee of 2,000 yen.

(8) Non-statutory items

Thirty non-statutory items, expected to be selected as medical examination items, were used to calculate the examination fees in a similar method used for the statutory items (Table 1-b).

2. Budget for medical examinations

The total fee for medical examinations with the minimum number of required test items (i.e., the statutory minimum) was set at 9,250 yen, while that for medical examinations with a maximum number of items (i.e., the statutory maximum) was 11,290 yen. The differences between the two fees can be attributed to the choice between brief and detailed examinations in the thoracic X-ray examination and examination by ECG, and the presence or absence of HbA1c tests (detailed examinations) in the examination of blood sugar levels (Table 1-a). While the examination of blood sugar levels is commonly performed using a blood glucose test, the HbA1c test is also available. Thus, the fee for a statutory minimum examination of blood sugar levels was calculated as that for a blood glucose test only, while the fee for a statutory maximum examination was calculated as the total fee for both tests. Considering the current status of the medical examinations, the cost for sputum examination was not included in the total fee for statutory medical examinations.

To identify the statutory medical examination items with the lowest priority, and non-statutory items with the highest priority, two types of budget plans were set before creating a questionnaire: Budget Plans 1 and 2. Budget Plan 1 (8,500 yen) was calculated as the amount divisible by 500 yen after subtracting 925 yen (i.e., 10% of 9,250 yen [statutory minimum]). Budget Plan 2 (12,000 yen) was calculated as the amount divisible by 500 yen after adding 925 yen (i.e., 10% of 9,250 yen [statutory minimum]).

3. Preliminary survey

A preliminary survey was conducted in November 2015. To clarify the priority of the periodical medical examination items, a questionnaire survey was administered to 11 occupational physicians (nine physicians with 1-2 years of practical experience in physician practice set-

tings, and two senior occupational health physicians certified by the Japanese Society for Occupational Health). In this survey, the examination items from the current statutory medical examination items and 30 non-statutory items within Budget Plans 1 (8,500 yen) and 2 (12,000 yen) could be freely chosen.

The results showed that all statutory items and 15 non-statutory items were chosen by at least one participant. As the accuracy of a survey decreases as the number of test items increases, the non-statutory items that were not chosen by anyone were excluded. As a result, a survey questionnaire was created with a total of 35 items, consisting of current statutory items and 15 non-statutory items (Table 1-b). In addition, all 11 participants responded that no other medical examination items needed to be included in the survey questionnaire.

Second step: Survey to assess medical item needs

Using the questionnaire, an email-based survey was conducted. To consolidate participants' opinions and increase the accuracy of the survey, participant responses were summarized and provided as feedback to the participants. This process of controlled feedback using the Delphi method¹⁷⁾ was repeated three times, from May to July 2016. The snowball sampling method was used to select a total of 134 physicians from occupational health physicians certified by the Japanese Society for Occupational Health, or occupational physicians with equivalent or more practical experience. A total of 62 of the 134 physicians provided written informed consent and were included in the study. The remaining 72 physicians were excluded because they did not consent to participate in this study.

Ethical considerations

This study was implemented with the approval of the institutional review board of the University of Occupational and Environmental Health, Japan (approval number: H27-232). Before providing written informed consent and prior to the study procedures being performed, all participants were provided with a sufficient explanation of voluntary withdrawal without penalty, and the protection of personal information.

Results

All 62 participants completed the three planned questionnaires (Fig. 1). The mean age of the participants was 37.5 ± 6.1 years. The mean years of experience as a physician was 12.4 ± 5.5 years. The mean years of experience as occupational physicians was 9.8 ± 5.1 years. A total of 48 (77%) participants were certified occupational physicians (occupational health physicians certified by the Japan Society for Occupational Health) or certified senior occupational physicians (senior occupational health phy-

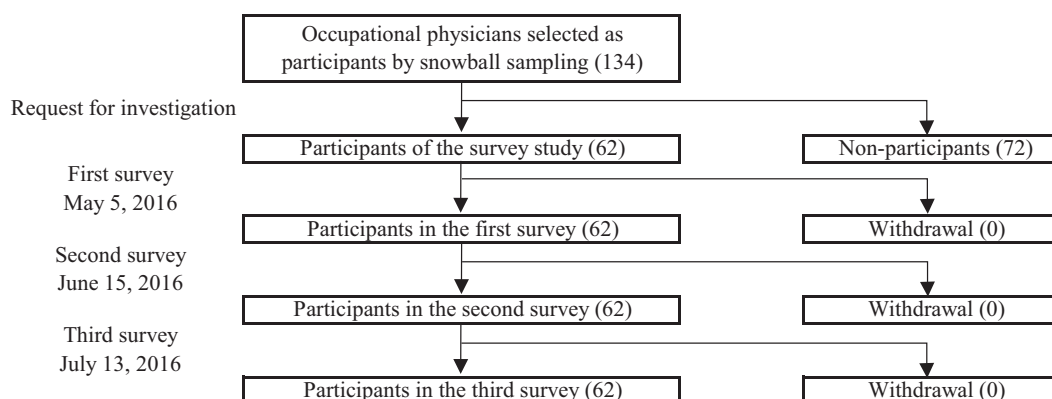


Fig. 1. Flowchart of the study process.

Table 2. Participant characteristics

	Number of participants	Percent (%)
Occupational physicians' years of experience		
3 to 4.9 years	6	9.7
5 to 9.9 years	30	48.4
10 to 14.9 years	15	24.2
15+ years	11	17.7
Qualification as a certified occupational physician		
Non-certified (but qualified as a certified clinical physician)	7 (1)	11.3 (1.6)
Certified associate occupational physician (qualified as a certified clinical physician)	7 (0)	11.3 (0)
Certified occupational physician/certified senior occupational physicians (qualified as a certified clinical physician)	48 (6)	77.4 (9.7)
Current primary practice		
Full-time industrial physician	48	77.4
Part-time industrial physician	13	21.0
Research	1	1.6
Relationship between affiliated organization and medical examinations		
Employed by an institution that provides medical examinations	5	8.1
Employed by a company and provides medical examinations within that organization	7	11.3
Employed by a company and generally provides only comprehensive assessments and follow-up of medical examinations	43	69.4

sicians certified by the Japan Society for Occupational Health); 7 (11%) were certified associate occupational physicians (associate occupational health physicians certified by the Japan Society for Occupational Health); and 48 (77%) were predominantly full-time physicians at large companies (Table 2).

The selection rate of each test item in the budget plans for the third questionnaire are shown in Table 3. Except for the items pertaining to brief examinations and detailed examinations, there was no significant difference in the order of priority of the test items between Budget Plans 1 and 2.

For Budget Plan 1 (8,500 yen), items ranging from a basic test (selection rate: 100%) to examination of hearing

(hearing test by interview: brief examination; selection rate 66%) were statutory items, while the only non-statutory item included in the budget plan was serum creatinine (58%; Table 3-a-1). Although waist circumference (15%), examination of hearing (air conduction pure-tone audiometry: detailed examination; 3%), and sputum examination (0%) were statutory items, they were not included in the budget plan (Table 3-a-2).

For Budget Plan 2 (12,000 yen), the selection rate of statutory items, other than waist circumference (39%) and sputum examination (2%), was more than 92% (Table 3-b-1). For non-statutory items, the selection rates of serum creatinine (95%), white blood cell count (92%), uric acid test (89%), and fecal occult blood reaction tests (81%)

Table 3. Selection rate of each test item in the budget plans for the third questionnaire

(a-1) Test items within Budget Plan 1 (8,500 yen)				
Selection rate (%)	Test item	Examination fee (yen)	Total fee (yen)	
100	Basic tests	2,820	2,820	
98	LDL cholesterol	180	3,000	
98	Hemoglobin content and erythrocyte count	80	3,080	
97	ALT	170	3,250	
95	AST	170	3,420	
92	Examination of the presence or absence of sugar and protein in urine	40	3,460	
92	Electrocardiogram examination (automatic determination only: brief examination)	1,300	4,760	
90	Thoracic X-ray examination (imaging diagnosis by a non-specialist: brief examination)	2,100	6,860	
87	γ -GTP	110	6,970	
87	HDL cholesterol	170	7,140	
82	Triglycerides	110	7,250	
77	Examination of eyesight	690	7,940	
77	Blood glucose (brief examination)	110	8,050	
66	Hearing (hearing test by interview: brief examination)	100	8,150	
58	Serum creatinine*	110	8,260	
(a-2) Test items outside of Budget Plan 1 (8,500 yen)				
55	HbA1c (detailed examinations)	490	8,750	
35	Fecal occult blood reaction*	90	8,840	
26	White blood cell count*	40	8,880	
23	Urine occult blood test*	20	8,900	
21	Uric acid*	110	9,010	
21	Platelet count*	40	9,050	
15	Waist circumference	100	9,150	
10	Urea nitrogen*	110	9,260	
5	Electrocardiogram (assessment by a specialist: detailed examinations)	2,000	11,260	
5	Thoracic X-ray examination (imaging diagnosis by a specialist: detailed examination)	2,950	14,210	
5	Total cholesterol*	170	14,380	
3	Hearing (air conduction pure-tone audiometry: detailed examination)	1,100	15,480	
2	Hematocrit levels*	40	15,520	
2	Body fat percentage*	100	15,620	
0	Total bilirubin*	110	15,730	
0	Sputum examination	320	16,050	
0	ALP*	110	16,160	
0	Potassium*	110	16,270	
0	PT*	180	16,450	
0	APTT*	290	16,740	

were over 80%. Although platelet counts (68%), urine occult blood (63%), urea nitrogen (45%), total cholesterol (31%), and hematocrit tests (27%) were included in the budget plan, their selection rates were 70% or lower.

The examination of hearing, thoracic X-rays, blood sugar levels, and ECGs had two options: brief and detailed examinations. Table 4 shows that participants preferred brief examinations to detailed examinations in

Budget Plan 1, and preferred detailed examinations to brief examinations in Budget Plan 2. For example, participants preferred the following: hearing tests by interview (66% in Budget Plan 1), air conduction pure-tone audiometry (93% in Budget Plan 2), thoracic X-ray examinations and imaging diagnosis by a non-specialist (90% in Budget Plan 1), thoracic X-ray examinations and imaging diagnosis by a specialist (97% in budget plan 2),

Table 3. Selection rate of each test item in the budget plans for the third questionnaire (continued)

(b-1) Test items within Budget Plan 2 (12,000 yen)

Selection rate (%)	Test items	Examination fee (yen)	Total fee (yen)
100	Basic tests	2,820	2,820
100	LDL cholesterol	180	3,000
100	Electrocardiogram (assessment by a specialist: detailed examination)	2,000	5,000
100	Triglycerides	110	5,110
98	Hemoglobin content and erythrocyte count	80	5,190
98	ALT	170	5,360
98	AST	170	5,530
98	Examination of the presence or absence of sugar and protein in urine	40	5,570
98	HDL cholesterol	170	5,740
98	Examination of eyesight	690	6,430
98	HbA1c (detailed examination)	490	6,920
97	γ -GTP	110	7,030
97	Thoracic X-ray examination (imaging diagnosis by a specialist: detailed examination)	2,950	9,980
95	Serum creatinine*	110	10,090
92	Hearing (air conduction pure-tone audiometry: detailed examination)	1,100	11,190
92	White blood cell count*	40	11,230
89	Blood glucose (brief examination)	110	11,340
89	Uric acid*	110	11,450
81	Fecal occult blood reaction*	90	11,540
68	Platelet count*	40	11,580
63	Urine occult blood test*	20	11,600
45	Urea nitrogen*	110	11,710
39	Waist circumference	100	11,810
31	Total cholesterol*	170	11,980

(b-2) Test items outside of Budget Plan 2 (12,000 yen)

27	Hematocrit levels*	40	12,020
19	Body fat percentage*	100	12,120
10	Hearing (hearing test by interview: brief examination)	100	12,220
6	Total bilirubin*	110	12,330
6	ALP*	110	12,440
3	Potassium*	110	12,550
2	Thoracic X-ray examination (imaging diagnosis by a non-specialist: brief examination)	2,100	14,650
2	Sputum examination	320	14,970
0	Examination by electrocardiogram (automatic determination only: brief examination)	1,300	16,270
0	PT*	180	16,450
0	APTT*	290	16,740

*Non-statutory items

Basic tests include investigation of anamnesis and work history, examination for the presence of subjective and objective symptoms, examination of height and weight, and blood pressure measurement.

AST- aspartate transaminase, ALT- alanine transaminase, GTP- guanosine triphosphate, HDL- high-density lipoprotein, LDL- low-density lipoprotein, HbA1c- glycated hemoglobin, ALP- alkaline Phosphatase, PT- prothrombin time, APTT- activated partial thromboplastin time

examination of blood sugar including blood glucose (79% in Budget Plan 1), glycated hemoglobin levels (98% in Budget Plan 2), examination by ECG including automatic

determination only (92% in Budget Plan 1), and assessment by a specialist (100% in Budget Plan 2).

The distribution of the total medical examination fees

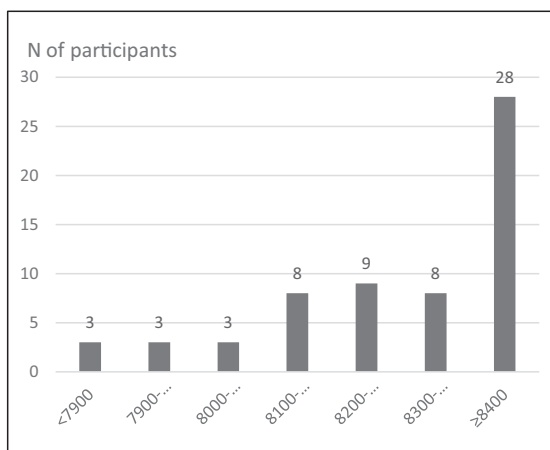
Table 4. Breakdown of the selection rate of hearing, thoracic X-ray, blood sugar level, and electrocardiogram examinations

	Examination of hearing		Thoracic X-ray examination		Examination of blood sugar		Electrocardiogram examination	
	Budget 1 (%)	Budget 2 (%)	Budget 1 (%)	Budget 2 (%)	Budget 1 (%)	Budget 2 (%)	Budget 1 (%)	Budget 2 (%)
Neither brief nor detailed examinations were selected	31	0	5	2	0	0	3	0
Only the brief examination was selected	66	6	90	2	47	2	92	0
Only the detailed examination was selected	3	90	5	97	21	11	5	100
Both brief and detailed examinations were selected	0	3	0	0	32	87	0	0

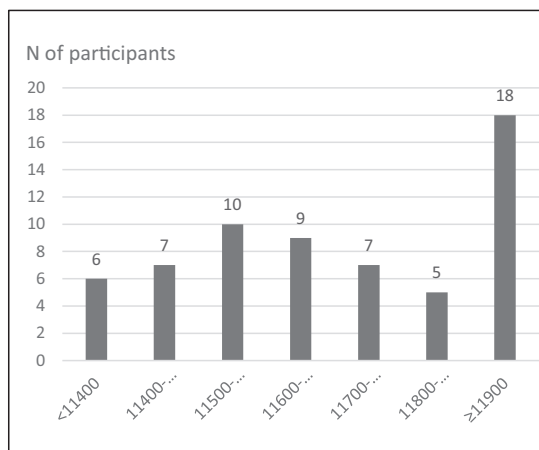
Brief examination: hearing test by interview, imaging diagnosis by a non-specialist, blood glucose, and automatic determination only (electrocardiogram)

Detailed examination: Air conduction pure-tone audiometry, imaging diagnosis by a specialist, HbA1c, and specialist assessment of electrocardiogram

(a) Budget Plan 1 (8,500 yen)



(b) Budget Plan 2 (12,000 yen)

**Fig. 2.** The distribution of total medical examination fees.

is shown in Fig. 2. In Budget Plan 1, 28 participants (45%) selected 8,400 to 8,500 yen as the total medical examination fee, and they chose the maximum number of items. In Budget Plan 2, 18 participants (29%) selected 11,900 to 12,000 yen, and 26 participants (42%) selected 11,400 to 11,700 yen (second peak).

Discussion

This is the first study to evaluate the order of priority of medical examination items from the viewpoint of occupational health, and it showed that many statutory items and some non-statutory items, such as serum creatinine, are given higher priority.

Our results showed that all the statutory items, except for waist circumference and sputum examination, were included in Budget Plan 1, with a lower budget than that

allocated by the statutory minimum. In addition, in Budget Plan 2, the selection rates of detailed examinations of statutory items (ECG: 100%, examination of blood sugar level: 98%, thoracic X-ray examination: 97%, and examination of hearing: 92%) were almost equal to or higher than those of non-statutory items with high selection rates (serum creatinine: 95%, and white blood cell count: 92%). Even in the higher budget plan, the items with higher accuracy were preferred to the non-statutory items. Thus, many of the current statutory medical examination items seem to have high utility in occupational health.

The high priority given to the statutory medical examination items could be attributed to their high utility in occupational health. Occupational physicians prefer to use blood pressure, hemoglobin content, ALT (examination of hepatic function), blood glucose, and HbA1c as exami-

nation items when considering employee fitness for work¹⁸. Body mass index (BMI), blood pressure, blood sugar, and blood lipids are risk factors for brain and heart diseases, and are affected by working conditions, such as shift work¹⁹. In addition, because these can be improved by improving one's lifestyle, they can be used for health guidance. The examination of eyesight is important in the assessment of job aptitude in specific tasks, such as in the automobile driving business, and is related to conditions such as asthenopia, which develops in those who perform visual display terminal work. Urinalysis (urine protein, urine glucose) fits the purpose of the medical examination as it can be used for the screening of kidney disease in participants with poor subjective symptoms. The low examination fee (40 yen) and associated cost-effectiveness may have appealed to participants. In addition to the early detection of lung cancer, X-ray examination may have been given a higher priority because the incidence of tuberculosis is higher in Japan than in many other developed countries²⁰, and can have a considerable impact on the workplace and customers. Examination by ECG is an important item for appropriate job placement with regards to hazardous operations such as driving tasks and high-altitude work, which can cause arrhythmias and the loss of consciousness. Statutory items seem to be easy to choose because they are currently used in medical examinations. However, even though waist circumference is a statutory item, it was not included in Budget Plan 1, suggesting that familiar items do not always have higher selection rates.

The selection rate of hearing examination (air conduction pure-tone audiometry: detailed examination) in Budget Plan 1 was 3%. Although this item was a statutory item, it was the main item that was deleted when switching from the statutory minimum (9,250 yen) to Budget Plan 1 (8,500 yen). As its selection rate in Budget Plan 2 was 92%, the priority was not very low. In a noisy workplace, where the risk of developing noise-induced hearing loss is high, the measurement of hearing should be carried out as a special medical examination. It is relatively easy to be aware of the symptoms of hearing loss, and a hearing test by interview (brief examination) can be used to some extent. The reason for the relatively low priority given to the item may be the cost difference between detailed examinations and brief examinations (1,000 yen).

Waist circumference has been a statutory item since the initiation of specific health checkups. In this study, it was given low priority and was not included in Budget Plan 1. Medical examinations conducted at workplaces may include the measurement of waist circumference immediately after eating or drinking, leading to poor measurement accuracy. Thus, it would be preferable to recommend the use of body weight and BMI, rather than waist circumference, which is a calculation based on both body weight and height as an indicator. Another reason for its

low priority may be that those with a low accumulation of visceral fat, along with high blood pressure, lipid abnormality, and hyperglycemia, can be at a risk of developing cardiovascular disease²¹.

Serum creatinine had the highest selection rate among the non-statutory items in both Budget Plans 1 and 2, and was the only non-statutory item that was included in Budget Plan 1. There may be several reasons for this. First, many occupational physicians restrict patients with increased serum creatinine levels from working¹⁸. It is useful to consider the restrictions on employment. Second, when screening for chronic kidney disease (CKD), the estimation error rate would be higher with only a urinary protein test and excluding the serum creatinine test²². In areas with a shortage of renal specialists, patients with positive urinary protein results may be asked to undergo urinalysis again, without serum creatinine, at a medical institution, due to failed screening for CKD. Third, in recent years, several companies and health insurance societies have been collaborating to improve the health of workers and fully utilize their medical expenses (CollaboHealth). However, some occupational physicians did not support the move to introduce dialysis treatment, as this requires a large medical expense. Fourth, an increase in the number of patients with positive urinary protein results may lead to an increase in the work burden and labor costs of occupational health staff who manage hospital visit records and recommend that patients visit a hospital. Thus, it would be more cost effective to add serum creatinine (110 yen). Fifth, as reduced glomerular filtration rate is an independent risk factor for cardiovascular disease²³, serum creatinine could be used to determine the order of priority given to the control of other risk factors and prioritize tasks required by occupational health staff, who consider the restrictions on employment and provide health guidance.

In Budget Plan 2, the non-statutory items with a selection rate >80%, with the exception of serum creatinine, were white blood cell count (92%), uric acid (89%), and fecal occult blood reaction (81%). White blood cell count can be used for the detection of leukemia and hematologic diseases²⁴, and is also useful for the risk and aptitude assessments in pathogen-related businesses and the hospitality industry, as well as to provide health guidance to smokers with an increased white blood cell count²⁵. Uric acid with poorly controlled hyperuricemia can cause gout attacks, thereby affecting work productivity by unexpected absences and pain. In addition, hyperuricemia is also a risk factor for hypertension, CKD, and cardiovascular events²⁶⁻²⁸. Colorectal cancer screening guidance²⁹ shows sufficient evidence for the mortality reduction effect of the fecal occult blood reaction. In addition, this test item has a low examination fee (90 yen). However, the medical evidence may not have been reflected in the selection rate, as using this in a company medical exami-

nation involves problems with collection and submission of specimens, in addition to problems with handling personal information that requires caution.

In Budget Plan 2 (12,000 yen), there were 32 participants (52%), with the total examination fee set at ≤ 11,600 yen. As there are many items priced at about 100 yen, the participants may not have regarded a medical examination with many items as a better choice. Participants may have considered the burden of after-care by occupational health staff, as the higher the number of items in a medical examination, the higher the corporate financial burden and anomaly observation rate.

Strengths and weaknesses of this study

The strengths of this study are that the participants were practicing occupational physicians. Of these, approximately 87% were certified occupational physicians, certified senior occupational physicians, or certified associate occupational physicians. All participants completed the three questionnaires. Thus, the changes in the selection rates were not due to the withdrawal of some participants.

This study also has some weaknesses. First, the participant characteristics are biased, as participants were selected through snowball sampling to enhance the collection rate. This study may not be representative of all opinions held by occupational physicians.

Second, the medical examination fees in this study may not reflect the actual fees, because they were calculated based on medical fee points. Waist circumference measurement, hearing test by interview, and anemia examination may have greater differences from the actual fees, as medical fee points could not be perfectly applied. However, the cost of medical examinations can be independently set by each institution that provides medical examinations. Even in a certified facility³⁰⁾, the total examination fees vary, and each examination fee is not always disclosed. The fee for waist circumference measurement is not listed in the medical fee points. It is possibly included in the basic test, as with blood pressure, 200-250 yen according to some facilities as announced in their website^{31,32)}. The fee for waist circumference measurement (100 yen) may be a reasonable price, because the fee is approximately the average fee. The priority of the hearing test by interview (brief test, 100 yen) would have likely been higher if it was offered for free and included the basic test, for which the medical fee points apply. The anemia examination (hemoglobin content and erythrocyte count) was 210 yen in total, including the white blood cell count, platelet count, and hematocrit and hemoglobin levels. It was assumed in this study that the five items (i.e., the general peripheral blood test) can be divided into each examination against the medical fee points; the fee for anemia examination was set at 40 yen. If not, that would lower the priority of the general peripheral blood test.

However, the influence of the examination fee was negligible, because the white blood cell count and platelet count had a relatively high selection rate.

Third, there is concern about whether the non-statutory items were selected appropriately. The preliminary survey using 11 participants showed that it was not necessary to add any other items to the questionnaire. Even in Budget Plan 2 (12,000 yen), some of the examination items (e.g., prothrombin time and activated partial thromboplastin time) were not chosen by any participants. Thus, the questionnaire seems to have all items required by the participants.

Fourth, the selection rate of each item was based on the feedback we received from participants; however, this feedback did not include the reason for selection of the items in the needs survey.

Conclusion

In conclusion, this study demonstrated that statutory items (except for waist circumference and sputum examination) and some of the non-statutory items (e.g., serum creatinine) were given higher priority from the viewpoint of occupational health. Further studies are needed to collect data from a larger sample of occupational physicians, and when new data is released regarding the items included in medical examinations.

Acknowledgments: We would like to express our sincere gratitude to our contributors and colleagues for providing guidance and support. This study was supported by a Health and Labor Science Research Grant, Occupational Safety and Health Research Project “Study of effective health management through periodic medical examinations that contribute to the prevention of work-related diseases” (Leader: Yasushi Okubo); and a Health and Labor Science Research Grant, Occupational Safety and Health Research Project “Understanding of specific workers on the actual situation and issues of the health checkup system” (Leader: Koji Mori).

Conflicts of interest: MK has a consulting contract with a medical examination agency. MK is the director of the National Federation of Industrial Health Organization.

References

- 1) Teramoto T, Sasaki J, Ishibashi S, et al; Japan Atherosclerosis Society. Executive summary of the Japan Atherosclerosis Society (JAS) guidelines for the diagnosis and prevention of atherosclerotic cardiovascular diseases in Japan -2012 version. *J Atheroscler Thromb* 2013; 20(6): 517-523.
- 2) Andrus B, Laccaille D. 2013 ACC/AHA guideline on the assessment of cardiovascular risk. *J Am Coll Cardiol* 2014; 63 (25 Pt A): 2886.
- 3) Expert Panel on Detection, Evaluation, and Treatment of High

- Blood Cholesterol in Adults. Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *JAMA* 2001; 285(19): 2486-2497.
- 4) Catapano AL, Graham I, De Backer G, et al; ESC Scientific Document Group. 2016 ESC/EAS guidelines for the management of dyslipidaemias. *Eur Heart J* 2016; 37(39): 2999-3058.
 - 5) Krogsbøll LT, Jørgensen KJ, Grønhoj Larsen C, et al. General health checks in adults for reducing morbidity and mortality from disease: Cochrane systematic review and meta-analysis. *BMJ* 2012; 345: e7191.
 - 6) Jørgensen T, Jacobsen RK, Toft U, et al. Effect of screening and lifestyle counselling on incidence of ischemic heart disease in general population: Inter99 randomized trial. *BMJ* 2014; 348: g3617.
 - 7) Fukui T, Okayama A, Tsuji I, et al. Research on health services based on latest scientific knowledge. Health Labour Sciences Research Grant, (Leader: Tsuguya Fukui) 2005 Summary research report. [Online]. 2005[cited 2018 Jun. 15]; Available from: URL: <http://mhlw-grants.niph.go.jp/niph/search/NIDD00.do?resrchNum=200400176A> (in Japanese).
 - 8) Japanese law translation (Ministry of Justice). Industrial Safety and Health Act. [Online]. 2009[cited 2017 Oct. 3]; Available from: URL: <http://www.japaneselawtranslation.go.jp/law/detail/?id=1926&vm=&re>
 - 9) ILO. Review of occupational safety and health activities of the ILO. In: Joint ILO/WHO committee on occupational health, the 11th session. Geneva: International Labour Organization; 1995.
 - 10) Bojlén NS, Lunde IM. Focus group interview as a qualitative research method. *Ugeskr Laeger* 1995; 157(23): 3315-3318.
 - 11) Mori K, Takebayashi T, Tatemichi M. An interview survey in certified occupational physicians on the effective use of periodical medical examinations. Health and Labor Science Research Grant, Occupational Safety and Health Research Project "Study of effective health management through periodic medical examinations that contribute to the prevention of work-related diseases (Leader: Yasushi Okubo)" 2014-2016 Summary research report. [Online]. 2017[cited 2017 Oct. 3]; Available from: URL: http://www.mhlw.go.jp/seisakunitsuite/bunya/koyou_roudou/roudoukijun/rousai/hojokin/dl/28_14020201-02_So.pdf (in Japanese).
 - 12) Medical fee points on the Web 2014. [Online]. 2014[cited 2015 Oct. 3]; Available from: URL: <http://2014.mfeesw.net/> (in Japanese).
 - 13) Shibata K, Suzuki S, Sato J, et al. Abdominal circumference should not be a required criterion for the diagnosis of metabolic syndrome. *Environ Health Prev Med* 2010; 15(4): 229-235.
 - 14) Ministry of Health, Labor and Welfare Cancer Research Grant. "Establishing an appropriate method of cancer screening and its evaluation method" study group. Japanese guideline for lung cancer screening based on effectiveness assessment 2006 (in Japanese).
 - 15) National Federation of Industrial Health Organization. Check lists for investigating evaluation of industrial health service functions. [Online]. 2016[cited 2017 Oct. 3]; Available from: URL: <http://www.zeneiren.or.jp/pdf/3-18.pdf> (in Japanese).
 - 16) Japan Society of Ningen Dock. Electrocardiogram examination assessment manual 2014 (in Japanese).
 - 17) Jones J, Hunter D. Consensus methods for medical and health services research. *BMJ* 1995; 311(7001): 376-380.
 - 18) Tateishi S, Watase M, Fujino Y, et al. The opinions of occupational physicians about maintaining healthy workers by means of medical examinations in Japan using the Delphi method. *J Occup Health* 2016; 58(1): 72-80.
 - 19) Fujino Y, Iso H, Tamakoshi A, et al; Japanese Collaborative Cohort Study Group. A prospective cohort study of shift work and risk of ischemic heart disease in Japanese male workers. *Am J Epidemiol* 2006; 164(2): 128-135.
 - 20) WHO. Global tuberculosis report 2017. World Health Organization, Geneva. [Online]. 2017[cited 2017 Dec. 20]; Available from: URL: <http://apps.who.int/iris/bitstream/10665/259366/1/9789241565516-eng.pdf?ua=1>
 - 21) Kadota A, Hozawa A, Okamura T, et al; NIPPON DATE Research Group. Relationship between metabolic risk factor clustering and cardiovascular mortality stratified by high blood glucose and obesity NIPPON DATA90, 1990-2000. *Diabetes Care* 2007; 30: 1533-1538.
 - 22) Uchida D, Kawarazaki H, Shibagaki Y, et al. Underestimating chronic kidney disease by urine dipstick without serum creatinine as a screening tool in the general Japanese population. *Clin Exp Nephrol* 2015; 19(3): 474-480.
 - 23) Nagai K, Yamagata K, Ohkubo R, et al. Annual decline in estimated glomerular filtration rate is a risk factor for cardiovascular events independent of proteinuria. *Nephrology (Carlton)* 2014; 19(9): 574-580.
 - 24) Moon Y, Kim MH, Kim HR, et al. The 2016 WHO versus 2008 WHO Criteria for the Diagnosis of Chronic Myelomonocytic Leukemia. *Ann Lab Med* 2018; 38(5): 481-483.
 - 25) Sakuragi S, Moriguchi J, Ohashi F, et al. Reference value and annual trend of white blood cell counts among adult Japanese population. *Environ Health Prev Med* 2013; 18(2): 143-150.
 - 26) Grayson PC, Kim SY, LaValley M, et al. Hyperuricemia and incident hypertension: a systematic review and meta-analysis. *Arthritis Care Res (Hoboken)* 2011; 63(1): 102-110.
 - 27) Zhu P, Liu Y, Han L, et al. Serum uric acid is associated with incident chronic kidney disease in middle-aged populations: a meta-analysis of 15 cohort studies. *PLoS One* 2014; 9(6): e100801.
 - 28) Alderman MH, Cohen H, Madhavan S, et al. Serum uric acid and cardiovascular events in successfully treated hypertensive patients. *Hypertension* 1999; 34(1): 144-150.
 - 29) Ministry of Health, Labor and Welfare Cancer Research Grant. "Establishing an appropriate method of cancer screening and its evaluation method" study group. Japanese guideline for colorectal cancer screening based on effectiveness assessment 2005 (in Japanese).
 - 30) National Federation of Industrial Health Organization. List of

- facilities providing evaluation of industrial health service functions. [Online]. 2017[cited 2017 Oct. 3]; Available from: URL: <http://www.zeneiren.or.jp/pdf/3-13.pdf> (in Japanese).
- 31) Public Interest Foundation of Yamagata Health Promotion System. The fee of the medical examination. [Online]. 2018 [cited 2018 Apr. 18]; Available from: URL: <http://www.yamagata-yobou.jp/exam/fee/> (in Japanese).
- 32) Tokyo-Hokuto Health Co-Operative Association. Optional items of the medical examination. [Online]. 2018[cited 2018 Apr. 18]; Available from: URL: http://www.t-hokuto.coop/clinic/health_check/ (in Japanese).