INTRODUCTION

Addiction, including both substance dependence (e.g., drugs, alcohol) and behavioral addiction (e.g., gaming, gambling), affects the mind, body, and social activities of the sufferer and has become a major social problem worldwide. According to a World Health Organization report, there are three million deaths per year due to alcohol harm and 350 million gamblers displaying problematic patterns each year. In recent years, there has been an increasing convergence between gaming and gambling, on various platforms, significantly aided by the internet. Behavioral addiction is becoming more of a problem, as a disease sensitive to social influences.

The prevalence of addiction varies widely by country or region due to differences of ethnicity, culture, education, social environment, and regulation. Each country or region needs to understand its current state of addiction and to take appropriate measures, in multidisciplinary collaboration. In order to understand the direction of addiction research in Japan, we analyzed 50 research and development topics and their characteristics, based on an expert questionnaire survey. The topics were placed in five categories, as follows. Category 1: Basic science; all 10 topics were of the Long-term project and International cooperation types. Category 2: Translational and clinical research; 6 out of 10 topics were of the Long-term project. Category 3: Fact-finding surveys; 8 out of 10 topics were of the Japan-specific type. Category 4: Health system and service; 8 out of 10 topics were of the Japan-specific type and Short-term project. Category 5: Study on society, culture, environment, education, and regulation; 7 out of 10 topics were of the Short-term project (similar to Category 4). As far as we know, this is the first systematic questionnaire survey on the direction of addiction research. The results of this study might support developing a strategy for addiction research, not only in Japan, but also in other countries.

KEYWORDS
addiction, category, Japan, questionnaire survey, research and development topic
understand its current state of addiction and take appropriate measures in multidisciplinary collaboration across psychiatry, internal medicine, pain medicine, psychology, pharmacology, neuroscience, pedagogy, and jurisprudence.

Japan has a problem with addiction; the number of addicted persons is estimated to be 100,000 for drug dependence, 800,000 for alcohol dependence, 3.2 million for gambling disorders, and 4.2 million for adults with internet addiction. Furthermore, there is a concern that the actual numbers are higher. Because there is a strong prejudice against addiction in Japan, sufferers do not readily admit they have addictions.

Treatments for addiction are, traditionally, rehabilitative services, along with supplemental medical and psychosocial services, to address multidimensional life problems. For substance dependence, research and development (R&D) into therapeutic drugs is ongoing worldwide; therapy using pharmaceutical drugs has been performed for some substances. On the other hand, there has been little R&D effort worldwide for behavioral addictions.

In Japan, in view of the need for approaches from various fields, based on national and regional conditions, the Addiction, Brain and Mind, and Neuroscience Subcommittees of the Science Council of Japan (AS-SCJ) proposed five necessary research activities for overcoming addiction problems (April 2020).

Our study describes a questionnaire survey of experts regarding these five recommendations. As far as we know, this is the first systematic questionnaire survey about the direction of addiction research. The results of this study might underpin development of a strategy for addressing addiction research, not only in Japan, but also in other countries.

2 | METHODS

2.1 | Survey design

This study involved a questionnaire survey. This type of survey is useful for involving people who may not be able to meet face-to-face; it provides some anonymity for responders and avoids social pressure to conform within groups. Questionnaire surveys have been employed in the fields of science, technology, and medicine for contributing to policy making.\(^5\,^6\)

### TABLE 1

| Category No. | Category |
|---------------|----------|
| 1             | Basic research |
| 2             | Translational research, clinical research (method development for prevention, diagnosis, treatment) |
| 3             | Fact-finding survey (search for risk factors through statistical surveys, genome research, and epidemiological studies) |
| 4             | Study on health system and health service |
| 5             | Study on society, culture, environment, education, and regulation |

2.2 | Participants

As leading experts in addiction research in Japan, members of the AS-SCJ\(^7\) and the Japanese Medical Society of Alcohol and Addiction studies (JMSAAS)\(^8\) participated in this study.

2.3 | Setting up R&D topics and survey items

As a first step, using an email survey (January 24 to February 14, 2019), we asked 26 executive officers (directors, auditors, and advisors) of JMSAAS about what candidates for future R&D are considered to be important for future addiction countermeasures in Japan. The candidate R&D topics were classified into five categories (Table 1), in consideration of various fields of research.

We collated the candidate topics as linkable, anonymized data and then narrowed and refined them into the set of topics for our questionnaire. In the process, we held a workshop (February 22, 2019) with members of AS-SCJ and obtained their advice.

2.4 | Questionnaire

In order to collect and analyze answers rapidly and efficiently, we used a web-based questionnaire. We invited 180 counselors of JMSAAS to participate in the survey, by email with the survey participation request form that clearly stated the purpose and content of the survey and the handling of personal information. Only counselors who agreed with the content responded.

Respondents selected any number of the five categories shown in Table 1 and then selected one from five options to provide qualitative evaluations for each R&D topic within each category, in terms of the time that researching on a specific theme would take (Short-term project, Somewhat shorter-term project, Neither short- nor long-term project, Somewhat longer-term project, Long-term project), and the extent of international collaboration (International cooperation type, Somewhat international cooperation type, Neither international cooperation nor Japan-specific type, Somewhat Japan-specific type, Japan-specific type).

A survey system provided by NTTCom Online Marketing Solutions Corporation (Tokyo, Japan) was utilized to administer the questionnaire;\(^9\) data collection was completed between February 21 and March 10, 2020.
2.5 | Statistical analysis and ethical consideration

For quantitative comparison of the questionnaire’s qualitative answers, each answer was quantified and its index calculated. First, each option selected by each respondent was converted into 1 to 5 points as shown in Table 2. Next, each point, from 1 to 5, was multiplied by the number of respondents for that point and the value of each product was calculated. Finally, the total value was divided by the total number of respondents for each topic.

Data analysis was performed using Excel 2016. The handling of data complied with the Research Activity Code of Conduct of the National Institute of Science and Technology Policy.

3 | RESULTS

3.1 | Setting up R&D topics

Twenty-six officers of JMSAAS provided 189 candidate topics for future R&D. The numbers of candidate topics are shown in Table 3.

The candidate topics were narrowed and refined to provide the topics for our questionnaire. Ten topics per category (50 topics in total) were included, in consideration of an appropriate number that would not burden respondents, and with equal numbers in each category, for comparative analysis of results. The candidate Other (Table 3) was included in the 50 topics, as appropriate.

3.2 | Questionnaire respondents

Of the 180 JMSAAS counselors invited to participate, 96 (53.3%) were respondents. Ages, affiliations, and occupations of the respondents are shown in Figure 1. The highest proportions of respondents were aged in their 60s, working for universities, and not responsible for clinical medicine.

3.3 | Results of answers to 50 R&D topics

The numbers of respondents and scores for each R&D topic are shown in Table 4 and Table S1. Category 1 (Basic research) had the greatest number of respondents (54); Category 4 (Study on health system and health service) had the least.

Regarding R&D period, the topic with the highest score (most long-term project) was Topic 3.2: Large-scale cohort study on addiction (score, 4.13); that with the lowest score (most short-term project) was Topic 4.1: Development of monitoring methods for addiction using wearable devices (score, 2.35). Regarding R&D system, the topic with the highest score (Japan-specific type) was Topic 3.10: Survey of addiction after the revision of the Health Promotion Act in Japan (score, 3.98); that with the lowest score (International cooperation type) was Topic 5.1: Development of systematic education programs for addiction and its prevention (score, 2.02).

3.4 | Characteristics of the R&D topics related to Basic research (Category 1)

Fifty-four experts (56.3%) responded to the R&D topics in Category 1, Basic research. All R&D topics were recognized to be of the long-term project/International cooperation type (Figure 2, dashed red area). The topic most considered the long-term project was Topic 1.1: Study on the role of each nervous system in addiction (score, 3.91). The topic most considered to be of the International cooperation type was Topic 1.2: Study on the neural basis of stress and resilience (score, 2.31).

3.5 | Characteristics of the R&D topics related to Translational and clinical research (Category 2)

Fifty-one experts (53.1%) responded to the R&D topics in Category 2, Translational and clinical research. Six out of 10 topics were recognized to be of the long-term project (Figure 3, dashed red area).

### TABLE 2 Quantification of questionnaire’s qualitative answers

| Indicators for evaluating the characteristics of research and development topic | Option for respondent to select | Conversion from each option to point*
|---|---|---
| The time that researching on a specific theme would take | Short-term project | 1 |
| | Somewhat shorter-term project | 2 |
| | Neither short- nor long-term project | 3 |
| | Somewhat longer-term project | 4 |
| | Long-term project | 5 |
| The extent of international collaboration | International cooperation type | 1 |
| | Somewhat international cooperation type | 2 |
| | Neither international cooperation nor Japan-specific type | 3 |
| | Somewhat Japan-specific type | 4 |
| | Japan-specific type | 5 |

*The quantification was conducted to compare questionnaire’s qualitative answers, and the numerical values themselves have no meaning such as degrees.
The topic most considered the Long-term project was Topic 2.5: Development of personalized prevention and treatment methods for addiction (score, 3.57).

3.6 | Characteristics of the R&D topics related to Fact-finding survey (Category 3)

Fifty-two experts (54.2%) responded to the topics in Category 3, Fact-finding survey. Eight out of 10 topics were recognized to be of the Japan-specific type (Figure 5, dashed red area) and the Short-term project (Figure 5, dashed blue area). The topic most considered to be of the Japan-specific type was Topic 3.10: Survey of addiction after the revision of the Health Promotion Act in Japan (score, 3.98).

3.7 | Characteristics of the R&D topics related to Health system and service (Category 4)

Thirty-one experts (32.3%) responded to the topics in Category 4, Health system and health service. Eight out of 10 topics were recognized to be of the Japan-specific type (Figure 5, dashed red area) and the Short-term project (Figure 5, dashed blue area). The topic most considered to be of the Japan-specific type was Topic 4.10: Study on an enhancement of cooperation among stakeholders in addiction treatment (score, 3.58); that considered the most Short-term project was Topic 4.1: Development of monitoring methods for addiction using wearable devices (score, 2.35).

3.8 | Characteristics of the R&D topics related to Study on society, culture, environment, education, and regulation (Category 5)

Forty-two experts (43.8%) responded to the topics in Category 5, Study on society, culture, environment, education, and regulation. Six out of 10 topics were recognized to be of the Japan-specific type (Figure 6, dashed red area) and 7 to be of the Short-term project (Figure 6, dashed blue area). The topic most considered to be of the Japan-specific type was Topic 5.6: Survey of Japanese prejudice against addiction (score, 3.95); that most considered to be of
### Table 4
Number of respondents, and scores related to the time that researching on a specific theme would take, and the extent of international collaboration

| Topic No. | Research and development topics                                                                 | Number of respondents | Time score<sup>a</sup> | International collaboration score<sup>b</sup> |
|-----------|--------------------------------------------------------------------------------------------------|-----------------------|------------------------|-----------------------------------------------|
|           | **Category 1. Basic research**                                                                  |                       |                        |                                               |
| 1.1       | Study on the role of each nervous system in addiction                                           | 54                    | 3.91                   | 2.43                                          |
| 1.2       | Study on the neural basis of stress and resilience                                             | 54                    | 3.65                   | 2.31                                          |
| 1.3       | Functional brain imaging in addiction                                                           | 54                    | 3.35                   | 2.52                                          |
| 1.4       | Study on common points and differences in addiction                                             | 54                    | 3.50                   | 2.63                                          |
| 1.5       | Study on the mechanism related to transition from repetition to addiction                       | 54                    | 3.69                   | 2.54                                          |
| 1.6       | Study on the neural mechanism underlying craving                                               | 54                    | 3.46                   | 2.43                                          |
| 1.7       | Development of animal models of addictive behavior                                              | 54                    | 3.41                   | 2.63                                          |
| 1.8       | Development of alternatives to animal experiments of addiction                                  | 54                    | 3.33                   | 2.61                                          |
| 1.9       | Development of biological markers for addiction                                                | 54                    |                        |                                               |
| 1.10      | Study on the relationship between addiction and peripheral organ damage                          | 54                    | 3.61                   | 2.70                                          |
|           | **Category 2. Translational research, clinical research**                                       |                       |                        |                                               |
| 2.1       | Exploratory study on endophenotypes for addiction                                              | 51                    | 3.39                   | 2.47                                          |
| 2.2       | Defining the severity of addiction                                                              | 51                    | 2.57                   | 2.69                                          |
| 2.3       | Development of an evaluation tool for the severity of addiction                                 | 51                    | 2.43                   | 3.02                                          |
| 2.4       | Development of a systematic screening method for exclusion diagnosis                             | 51                    | 2.55                   | 3.02                                          |
| 2.5       | Development of personalized prevention and treatment methods for addiction                     | 51                    | 3.57                   | 3.16                                          |
| 2.6       | Development of clinical classification of treatment responsiveness and corresponding guidelines   | 51                    | 2.96                   | 3.16                                          |
| 2.7       | Development of common cognitive behavioral therapy for addiction                                | 51                    | 3.20                   | 3.24                                          |
| 2.8       | Development of common anti-craving drugs for addiction                                           | 51                    | 3.49                   | 2.59                                          |
| 2.9       | Study on the mechanism of addiction complicated by depression                                   | 51                    | 3.39                   | 2.67                                          |
| 2.10      | Study on effectiveness of self-help group                                                        | 51                    | 3.38                   | 3.53                                          |
|           | **Category 3. Fact-finding survey**                                                              |                       |                        |                                               |
| 3.1       | Study on individual and ethnic differences in addiction development                              | 52                    | 3.60                   | 2.29                                          |
| 3.2       | Large-scale cohort study on addiction                                                           | 52                    | 4.13                   | 3.29                                          |
| 3.3       | Survey of addiction in minors                                                                   | 52                    | 2.83                   | 3.40                                          |
| 3.4       | Survey of lifestyle-related diseases in patients with addiction                                  | 52                    | 2.92                   | 3.33                                          |
| 3.5       | Survey of family psychology about addiction                                                      | 52                    | 2.92                   | 3.37                                          |
| 3.6       | Survey of the relationship between addiction and regional characteristics                        | 52                    | 3.00                   | 3.54                                          |
| 3.7       | Survey of hospital consultation due to addiction development                                    | 52                    | 2.52                   | 3.58                                          |

(Continues)
| Topic No. | Research and development topics | Number of respondents | Time score<sup>a</sup> | International collaboration score<sup>b</sup> |
|-----------|---------------------------------|-----------------------|-------------------------|-----------------------------------------------|
| 3.8       | Investigation of addiction-related death | 52                    | 3.19                    | 3.25                                          |
| 3.9       | Construction of a diversified brain imaging database for addiction | 52                    | 3.87                    | 2.58                                          |
| 3.10      | Survey of addiction after the revision of the Health Promotion Act in Japan | 52                    | 3.19                    | 3.98                                          |

**Category 4. Study on health system and service**

|               |                                                                 | Number of respondents | Time score<sup>a</sup> | International collaboration score<sup>b</sup> |
|---------------|-----------------------------------------------------------------|-----------------------|-------------------------|-----------------------------------------------|
| 4.1           | Development of monitoring methods for addiction using wearable devices | 31                    | 2.35                    | 3.16                                          |
| 4.2           | Study on ICT applications in addiction treatment                 | 31                    | 2.39                    | 2.68                                          |
| 4.3           | Construction of support models for addiction patients considering gender differences | 31                    | 3.16                    | 3.00                                          |
| 4.4           | Study on the role of psychotherapist for treatment and prevention of addiction | 31                    | 2.97                    | 3.45                                          |
| 4.5           | Study on a stress check of health professionals for addiction  | 31                    | 2.84                    | 3.52                                          |
| 4.6           | Study on an economic loss caused by addiction                   | 31                    | 2.97                    | 3.10                                          |
| 4.7           | Study on a cost and benefit of addiction treatment              | 31                    | 3.10                    | 3.19                                          |
| 4.8           | Study on a future legislation for addiction                    | 31                    | 2.94                    | 3.26                                          |
| 4.9           | Survey of overseas health system and health service status      | 31                    | 2.55                    | 2.32                                          |
| 4.10          | Study on an enhancement of cooperation among stakeholders in addiction treatment | 31                    | 2.87                    | 3.58                                          |

**Category 5. Study on society, culture, environment, education, and regulation**

|               |                                                                 | Number of respondents | Time score<sup>a</sup> | International collaboration score<sup>b</sup> |
|---------------|-----------------------------------------------------------------|-----------------------|-------------------------|-----------------------------------------------|
| 5.1           | Development of systematic education programs for addiction and its prevention | 42                    | 2.64                    | 2.02                                          |
| 5.2           | Survey of medical education for addiction                      | 42                    | 2.60                    | 2.98                                          |
| 5.3           | Study on teacher training for prevention of addiction          | 42                    | 2.79                    | 3.00                                          |
| 5.4           | International comparative study on school education for addiction | 42                    | 2.79                    | 3.17                                          |
| 5.5           | Study on enhancement of Japanese people's literacy for addiction | 42                    | 3.10                    | 3.62                                          |
| 5.6           | Survey of Japanese prejudice against addiction                 | 42                    | 2.74                    | 3.95                                          |
| 5.7           | Study on acceptance of self-help groups to the general population | 42                    | 2.81                    | 3.69                                          |
| 5.8           | Study on the relationship between stricter punishment and legislation and changes in the number of addiction patients | 42                    | 3.12                    | 3.31                                          |
| 5.9           | International comparative study on ELSI countermeasures related to addiction | 42                    | 2.81                    | 2.19                                          |
| 5.10          | Study on the effectiveness of harm reduction policy in Japan    | 42                    | 3.36                    | 3.60                                          |

<sup>a</sup>Scores related to the time that researching on a specific theme would take.

<sup>b</sup>Scores related to the extent of international collaboration.
** FIGURE 2 ** Characteristics of the research and development topics related to Basic research (Category 1). The number of respondents was 54. The number of each research and development topic corresponds to the number in Table 4.

** FIGURE 3 ** Characteristics of the research and development topics related to Translational and clinical research (Category 2). The number of respondents was 51. The number of each research and development topic corresponds to the number in Table 4.
FIGURE 4 Characteristics of the research and development topics related to Fact-finding survey (Category 3). The number of respondents was 52. The number of each research and development topic corresponds to the number in Table 4.

FIGURE 5 Characteristics of the research and development topics related to Health system and service (Category 4). The number of respondents was 31. The number of each research and development topic corresponds to the number in Table 4.
Short-term project was Topic 5.2: Survey of medical education for addiction (score, 2.60).

4 | DISCUSSION

This study identified future R&D topics for developing effective addiction countermeasures in Japan, based on a questionnaire survey of experts. A wide variety of candidate topics ranged from basic science to social science. As far as we know, this is the first systematic questionnaire survey for direction of addiction research.

In Basic science (Category 1), all 10 R&D topics were recognized to be of the Long-term project/International cooperation type. Research on addiction requires Long-term support at national level and International cooperation, such as data sharing.

In Translational and clinical research (Category 2), the majority of topics were recognized to be of the Long-term project. For the topic most considered to be of the Long-term project, Topic 2.5 (Development of personalized prevention and treatment methods for addiction), precision medicine is considered to be as important for addiction as it is for cancer and lifestyle diseases.

In Fact-finding survey (Category 3), almost all (8/10) topics were recognized to be of the Japan-specific type. Topic 3.10, Survey of addiction after the revision of the Health Promotion Act in Japan, which was the most Japan-specific type, is unique to Japan and needs to proceed with wide-ranging investigation from the perspective of public health. Addiction varies with different situations in each country or region, so it is considered necessary to develop appropriate measures for each situation.

Concerning Health system and service (Category 4), almost all (8/10) topics were recognized to be of the Japan-specific type and Short-term project. Topic 4.10 (Study on an enhancement of cooperation among stakeholders in addiction treatment) was most considered to be of the Japan-specific type. Since healthcare conditions vary, depending on national and regional socioeconomic conditions, it is considered necessary to take measures in cooperation with stakeholders.

Regarding study on society, culture, environment, education, and regulation (Category 5), many topics were recognized to be of the Short-term project, similar to Category 4. This contrasts with the topics of Categories 1 through 3. Since the factors of society, culture, environment, education, and regulations differ between countries and regions, it is considered necessary to take appropriate measures for each situation.

Five recommendations to promote future addiction research in Japan were proposed in April 2020. These were formulated through discussion among the members of AS-SCJ, based on the results of this study and other related studies. The recommendations are summarized below:

1. Understand diversity in addiction and promote related research and education.
2. Promote personalized measures for patients with addiction disorders.
3. Foster addiction research personnel.
4. Develop new guidelines for the rehabilitation of patients with drug dependence.
5. Establish an institute that specializes in addiction research and comprehensively handles information collection, research, countermeasures, treatment, and public relations related to addiction.

Recommendation 1 reflects this study’s results, after setting a wide range of 50 topics in five categories.
Recommendation 2 reflects the importance of precision medicine, as shown by analysis of our Category 2 topics.
Recommendations 3 through 5 involve and reflect public health, science, and technology policies about human resources, guidelines, and research institutions.

In considering the direction of future addiction research, an approach like ours, which makes recommendations based on the results of expert questionnaires, is valuable, not only in Japan, but also in other countries.

5 | INFORMED CONSENT

We invited the counselors of JMSAAS by email with the survey participation request form that clearly stated the purpose and content of the survey and the handling of personal information. Only counselors who agreed with the content participated in this study.

ETHICS APPROVAL STATEMENT
The handling of data complied with the Research Activity Code of Conduct of the National Institute of Science and Technology Policy.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest associated with this manuscript.

AUTHOR CONTRIBUTIONS
All authors contributed toward data collection and analysis and revision of the manuscript and agree to be accountable for all aspects of this study.

DATA AVAILABILITY STATEMENT
Statistical data about answers are available in the supplementary information of our article.

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Supporting Information
Additional supporting information may be found online in the Supporting Information section.

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