Prevalence of diabetes among homeless men in Nagoya, Japan: A survey study

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INTRODUCTION
Various epidemiological studies have shown a worldwide increase in the prevalence of diabetes mellitus1. Patients with diabetes use health services more frequently and for longer; thus, they have more healthcare costs than people without diabetes2. Because those with diabetes frequently have major complications, such as coronary heart disease, stroke and nephropathy, they require more healthcare and social support. However, the prevalence of diabetes in homeless people has not been elucidated because of the limited access to this population. Although diabetes patients require integrated multi-team support, many homeless people stop accessing continuous medical care for two main reasons. The first reason is that most of them have lost their national health insurance, and gaining access to free medical services is a complicated process; they have to visit city hall first to collect a 1-day free ticket for medical care every time they visit a medical institution. The second reason is that most diabetes patients have no subjective symptoms before the onset of serious diabetic complications. Precise data of the diabetes prevalence might provide evidence for creating a support system for homeless people managing their diabetes.

The only available information about the prevalence of diabetes in the homeless population is two surveys from France3 and Ireland4, and a meta-analysis from the USA5. To the best of our knowledge, there have been no reports on the diabetes
prevalence and related sociodemographic background among
the Japanese homeless population.

In the present study, we carried out a survey among home-
less men in Nagoya, Japan, to examine the prevalence of dia-
abetes and its association with mental illness, cognitive disability
and various social factors.

METHODS
The participants in the present study were recruited in coopera-
tion with the Sasashima Support Center non-governmental
organization on 2 November 2014 in Nagoya, Japan. Although
the detailed methodology of the study design has been
described previously, the protocol of this survey is described
here in brief.

The definition of homelessness used in the present study was
according to the United States Department of Health and
Human Services’ term “literal homelessness,” which refers to
individuals with no stable residence living either in a temporary
shelter or unsheltered location not meant for habitation (e.g.,
the street, a subway station or parked car). A total of 114
homeless people were screened for this survey. As the number
of women participants was too small for a clinically mean-
ingful analysis and discussion, we excluded the data of women.
The remaining 106 men with a mean age of 54.2 ± 12.7 years
(range 20–78 years) were included in the present analysis.

Measurements
Participants’ age, residence status, duration and history of
homelessness, alcohol consumption, tobacco smoking status,
gambling status, history of social support, pension status, and
education levels were obtained by medical professionals through
interviews. Semi-structured interviews were carried out by psy-
chiatrists to evaluate participants’ mental status using the Mini-
International Neuropsychiatric Interview according to the Diag-
nostic and Statistical Manual of Mental Disorders, Fourth Edi-
tion, Text Revision. Each participant’s current mental capacity
was assessed by clinical psychologists using the Wechsler Adult
Intelligence Scale III simplified version, Dairoku et al.’s
method, and cognitive disability was defined as an Intelligence
Quotient <70. Height, bodyweight, blood pressure and the
hematocrit level were also measured, and body mass index was
calculated using the following formula: bodyweight
(kg) / [height (m)]².

Diabetes screening was carried out by measuring serum
hemoglobin A1c (HbA1c) levels according to the criteria of a
national survey of public health and nutrition, the Japan
National Health and Nutrition Survey, carried out by the Japa-
nese Ministry of Health, Labor and Welfare. Participants who
answered, “I have diabetes mellitus” or had an HbA1c value
≥6.5% were considered to have diabetes mellitus, those who
had an HbA1c value of 6.0–6.4% were considered to have pre-
diabetes and other participants were considered to be normal.
We used the HbA1c level for diabetes screening rather than the
result of the 75-g oral glucose tolerance test in order to
minimize participants’ pain burden, and because it was consid-
ered very difficult to ensure that participants followed the pro-
cedure for the 75-g oral glucose tolerance test: fasting for
≥12 h, undergoing blood sampling four times, and abstaining
from eating and drinking until the final blood sample was
obtained at 120 min after starting the test because of their
socioeconomic status and various degrees of mental health.

Associations between participants’ sociodemographic back-
ground or mental illness/cognitive disability, and the prevalence
of diabetes and prediabetes were analyzed.

Statistical analysis
Odds ratios were calculated, and statistical significance was
accepted when the 95% confidence interval for the mean differ-
ce was not 0, when the 95% confidence interval for the ratio
was not 1.0 and when the P-value was <0.05. All statistical
analyses were carried out using JMP® software, version 10.0.2
(SAS Institute, Tokyo, Japan).

Ethical considerations
The present study protocol was approved by the Ethical Review
Committee, Graduate School of Medicine, Gifu University on 6
August 2014 (approval no.: 26-133), and it conforms to the
provisions of the Declaration of Helsinki (as revised in Fort-
taleza, Brazil, October 2013). All participants provided written
informed consent. Participants identified as requiring medical
treatment were referred on the same day to appropriate medi-
cal institutions.

RESULTS
Participants’ sociodemographic background
All participants were Japanese in ethnicity and nationality. Most
of them lived on the street (63.2%, n = 67) for <1 year (54.7%,
n = 58) without a previous history of homelessness (59.4%,
n = 63) or an alcohol drinking habit (61.3%, n = 65). A total
of 28 (26.4%) participants were overweight/obese (body mass
index ≥25 kg/m²), and just five (4.7%) had a body mass index
<18.5 kg/m². A total of 10 (9.4%) participants had a family his-
tory of diabetes mellitus (Table 1). Although 53 participants
(50.0%) had experience receiving social support, 94 (88.7%) did
not receive any pensions. Of 106 participants, 45 (42.4%) were
diagnosed as having a mental illness, including schizophrenia,
mood disorders, anxiety disorders, personality disorders, and
alcohol dependence and/or abuse, 34 (32%) were diagnosed as
having a cognitive disability, and 15 (14.2%) participants were
diagnosed as having both mental illness and cognitive disability.

Prevalence of diabetes and prediabetes among homeless men
The prevalence of diabetes and prediabetes in 106 homeless
men were 6.6% (n = 7) and 11.3% (n = 12), respectively
(Table 2). According to the increase of age, the prevalence of
prediabetes increased from 0% in those aged 20–29 years
to 19.4% in those aged 60–69 years and 20.0% in those aged
≥70 years. Although a diagnosis of diabetes/prediabetes by
screening was made based on the HbA1c levels, not results of the 75-g oral glucose tolerance test, no participants showed a discrepancy between blood glucose and HbA1c levels (Table 2). In addition, no participants had severe anemia that might affect HbA1c levels. The mean \(- \text{standard deviation of participants'}\) hematocrit level was 41.9 \(- 3.4\% \text{ (minimum 34.6\%, maximum 48.8\%).]

### Diabetes or prediabetes prevalence and sociodemographic background

The distributions of 106 participants in each diabetic category (diabetes mellitus, prediabetes and normal) stratified according to various mental/cognitive and sociodemographic factors are shown in Table 3. The prevalence of prediabetes was significantly higher in the group without social support than in that without social support. There were no significant associations between the prevalence of diabetes/prediabetes and other factors, such as having a mental illness/cognitive disability, residence, current duration and previous experience with homelessness, lifestyle habits (e.g., smoking and alcohol consumption), and education levels.

### DISCUSSION

Diabetes is a global health problem causing increased morbidity and mortality; therefore, the prevention, early detection and appropriate treatment are required for all populations. The number of people with diabetes is projected to increase in developed and developing countries\(^5\). This trend has been more

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**Table 1 | Sociodemographic background of participants**

| Total, \(n = 106\) (%) |
|-------------------------|
| **Age (years)**         |
| 20–29                   | 5 (4.7) |
| 30–39                   | 11 (10.4) |
| 40–49                   | 22 (20.8) |
| 50–59                   | 27 (25.5) |
| 60–69                   | 31 (29.2) |
| ≥70                     | 10 (9.4) |
| **BMI (kg/m\(^2\))**    |
| <18.5                   | 5 (4.7) |
| 18.5–24.9               | 73 (68.9) |
| ≥25.0                   | 28 (26.4) |
| **Family medical history** |
| Diabetes (+)            | 10 (9.4) |
| Hypertension (+)        | 8 (7.5) |
| Cancer (+)              | 16 (15.1) |
| **Mental illness and cognitive disability** |
| Normal                  | 42 (39.6) |
| Intellectual disability | 19 (17.9) |
| Mental illness          | 30 (28.3) |
| Both                    | 15 (14.2) |
| **Residence**           |
| Street                  | 67 (63.2) |
| Temporary residence     | 33 (31.1) |
| Other                   | 3 (2.8) |
| Unknown                 | 3 (2.8) |
| **Duration of homeless life (years)** |
| ≤1                      | 58 (54.7) |
| >2                      | 9 (8.5) |
| >3                      | 8 (7.5) |
| >4                      | 5 (4.7) |
| >5                      | 6 (5.7) |
| >10                     | 13 (12.3) |
| ≥11                     | 7 (6.6) |
| **History of homelessness (times)** |
| ≤1                      | 63 (59.4) |
| >2                      | 19 (17.9) |
| >3                      | 11 (10.4) |
| >4                      | 3 (2.8) |
| >5                      | 4 (3.8) |
| >10                     | 4 (3.8) |
| ≥11                     | 2 (1.9) |
| **Alcohol consumption** |
| Nothing                 | 65 (61.3) |
| 1                       | 2 (1.9) |
| 2                       | 9 (8.5) |
| 3                       | 2 (1.9) |
| 4–5                     | 3 (2.8) |
| 6–10                    | 8 (7.5) |
| 11–20                   | 8 (7.5) |
| >20                     | 9 (8.5) |
| **Smoking (no. cigarettes/day)** |
| Nothing                 | 33 (31.1) |
| 1–10                    | 26 (24.5) |
| 11–20                   | 40 (37.7) |

**Table 1 (Continued)**

| Total, \(n = 106\) (%) |
|-------------------------|
| **History of social support** |
| (+)                      | 53 (50.0) |
| (−)                      | 53 (50.0) |
| **Pension**              |
| Nothing                  | 94 (88.7) |
| Basic pension            | 4 (3.8) |
| Employees’ pension       | 6 (5.7) |
| Disability pension       | 0 (0.0) |
| Others                   | 2 (1.9) |
| Unknown                  | 0 (0.0) |
| **Education level**      |
| Junior high              | 48 (45.3) |
| Senior high              | 49 (46.2) |
| College or more          | 7 (6.6) |
| **History of gambling**  |
| Yes                      | 36 (34.0) |
| Not now                  | 45 (42.5) |
| Never                    | 25 (23.6) |

\(^{†}\)Number of 200-mL wine glasses/week. BMI, body mass index.
Table 2  Prevalence of hemoglobin A1c and blood glucose levels in each generation

| Age (year) | Total | HbA1c(%) | Prevalence | Blood glucose | Prevalence | Blood glucose | Prevalence | Blood glucose | Prevalence | Blood glucose | Prevalence | Blood glucose | Prevalence | Blood glucose |
|------------|-------|----------|------------|---------------|------------|---------------|------------|---------------|------------|---------------|------------|---------------|------------|---------------|
| <59        | 87    | 82.1     | 6.0-6.4    | 121.13       | 5100       | 8809±5.19    | 1864       | 8805±12.73   | 9181       | 845±6.13     | 19         | 45           | 38         | 45           |
| 60-69      | 297   | 82.1     | 6.0-6.4    | 121.13       | 5100       | 8809±5.19    | 1864       | 8805±12.73   | 9181       | 845±6.13     | 19         | 45           | 38         | 45           |
| 70-79      | 324   | 82.1     | 6.0-6.4    | 121.13       | 5100       | 8809±5.19    | 1864       | 8805±12.73   | 9181       | 845±6.13     | 19         | 45           | 38         | 45           |
| ≥80        | 324   | 82.1     | 6.0-6.4    | 121.13       | 5100       | 8809±5.19    | 1864       | 8805±12.73   | 9181       | 845±6.13     | 19         | 45           | 38         | 45           |

Table ment that the estimated prevalence of diabetes in homeless people was 6.2%. A study of Irish homeless people showed that 10% and 21% of the study population had diabetes and prediabetes, respectively. The present study is the first to show the diabetes/prediabetes prevalence in an Asian homeless population. The data presented herein will be a valuable resource for health policymakers in providing health support for homeless people in Japan and Asia. Tsai et al. also advocated that obtaining accurate prevalence estimates is important to progress social support, including allocation of governmental resources. Although there are barriers to accessing medical care services in the homeless population, preventive programs for diabetes might be cost-effective if targeted at the homeless population with a high diabetes/prediabetes prevalence that is almost the same level as that in the national survey data in Japan. The social welfare service served high-energy meals that were mainly popular items, such as curry and rice or meat and vegetables over rice, at least twice a day. Therefore, most participants might have had almost the same nutrition level as the general population, and this might be why the prevalence of diabetes in homeless people was the same as that in national survey data. No participants were malnourished, and 73 (68.9%) and 28 (26.4%) participants were normal and overweight/obese, respectively. Diabetes is a very costly disease once diabetic complications develop, including blindness induced by diabetic retinopathy, amputation induced by diabetic neuropathy and hemodialysis induced by diabetic nephropathy, which require huge budgets for social support and medical expenditure. If diabetes patients without medical care reach the requirement for hemodialysis therapy, they will incur substantial medical costs until the end of their life. Conversely, diabetes patients taking only oral medication will incur this medical expense in the long term, but their life-long medical expenditure might be far less than that for hemodialysis per year. The preventive approach for diabetes should be as...
cost-effective for homeless people as it is for the general population. On the basis of the same viewpoint, Morrison indicated that homelessness is more hazardous than being in conventional deprived socioeconomic circumstances, and homeless people might benefit from more intensive targeted health and social interventions. We showed a significant relationship between previous experiences of social support and diabetes/prediabetes prevalence, indicating that interventions improving physical health with social support might be effective for directly or indirectly preventing diabetes. We previously reported that the high percentage of mental illness and cognitive disability in Japanese homeless people was similar to that of homeless people in Western countries. Coordinated programs for diabetes prevention/treatment with mental health and cognitive support should be required for homeless people. Effective interventions could improve health and increase access to medical institutions among homeless populations, as Fitzpatrick-Lewis et al. showed. Previous review papers emphasized that interventions to improve health through the coordinated support for access to healthcare was found to be important because of the high prevalence of mental health problems in this population. Interventions to access social support and medical care might improve the health condition of homeless people, thereby facilitating their transition back to a stable social life and potentially decreasing their prevalence of diabetes.

The present study had a limitation. We carried out a cross-sectional, single-day survey design and participants were recruited from a single site, although the majority of homeless people live near Nagoya station area. Therefore, we could not

| Table 3 | Participants’ diabetes prevalence according to hemoglobin A1c levels, stratified by background |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| HbA1c (%)                                      | ≤5.9                          | 6.0–6.4                        | ≥6.5                          | Total                          |
|                           | n    | %   | n    | %   | n    | %   | n    | %   |
| **Total**                     | 87   | 82.1 | 12   | 11.3 | 7    | 6.6 | 106  | 100.0 |
| Mental illness/cognitive disability |       |       |      |       |      |     |       |       |
| Normal                        | 34   | 81.0 | 5    | 11.9 | 3    | 7.1 | 42   | 100.0 |
| Cognitive disability          | 16   | 84.2 | 2    | 10.5 | 1    | 5.3 | 19   | 100.0 |
| Mental illness                | 26   | 86.7 | 3    | 10.0 | 1    | 3.3 | 30   | 100.0 |
| Cognitive disability + mental illness | 11   | 73.3 | 2    | 13.3 | 2    | 13.3| 15   | 100.0 |
| Residence                      |       |       |      |       |      |     |       |       |
| Street                        | 54   | 80.6 | 8    | 11.9 | 5    | 7.5 | 67   | 100.0 |
| Others                        | 30   | 83.3 | 4    | 11.1 | 2    | 5.6 | 36   | 100.0 |
| Duration of homelessness (years) |       |       |      |       |      |     |       |       |
| 1                             | 50   | 86.2 | 5    | 8.6  | 3    | 5.2 | 58   | 100.0 |
| ≥2                            | 37   | 77.1 | 7    | 14.6 | 4    | 8.3 | 48   | 100.0 |
| Past experience of homelessness (times) |       |       |      |       |      |     |       |       |
| 1                             | 52   | 82.5 | 6    | 9.5  | 5    | 7.9 | 63   | 100.0 |
| ≥2                            | 35   | 81.4 | 6    | 14.0 | 2    | 4.7 | 43   | 100.0 |
| Alcohol consumption           |       |       |      |       |      |     |       |       |
| –                             | 51   | 78.5 | 8    | 12.3 | 6    | 9.2 | 65   | 100.0 |
| +                             | 36   | 87.8 | 4    | 9.8  | 1    | 2.4 | 41   | 100.0 |
| Tobacco smoker                |       |       |      |       |      |     |       |       |
| –                             | 27   | 81.8 | 3    | 9.1  | 3    | 9.1 | 33   | 100.0 |
| +                             | 60   | 82.2 | 9    | 12.3 | 4    | 5.5 | 73   | 100.0 |
| Gambling                      |       |       |      |       |      |     |       |       |
| –                             | 24   | 96.0 | 1    | 4.0  | 0    | 0.0 | 25   | 100.0 |
| +                             | 27   | 75.0 | 6    | 16.7 | 3    | 8.3 | 36   | 100.0 |
| + Previously, not now         | 36   | 80.0 | 5    | 11.1 | 4    | 8.9 | 45   | 100.0 |
| Experience with social support |       |       |      |       |      |     |       |       |
| –                             | 40   | 75.5 | 10   | *18.9| 3    | 5.7 | 53   | 100.0 |
| +                             | 47   | 88.7 | 2    | *3.8 | 4    | 7.5 | 53   | 100.0 |
| Pension                       |       |       |      |       |      |     |       |       |
| –                             | 77   | 81.9 | 10   | 10.6 | 7    | 7.4 | 94   | 100.0 |
| +                             | 10   | 83.3 | 2    | 16.7 | 0    | 0.0 | 12   | 100.0 |
| Education level               |       |       |      |       |      |     |       |       |
| Less than senior high school  | 47   | 82.5 | 5    | 8.8  | 5    | 8.8 | 57   | 100.0 |
| Senior high school or more    | 38   | 80.9 | 7    | 14.9 | 2    | 4.3 | 47   | 100.0 |

χ²-tests *P < 0.05. HbA1c, hemoglobin A1c.
confirm whether social support intervention could prevent diabetes mellitus. To overcome this limitation, an additional follow-up study would be required.

The prevalence of diabetes among homeless men in Japan was almost similar to that of the general population; thus, early detection and effective intervention for diabetes/prediabetes might be required in the homeless population.

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DISCLOSURE
The authors declare no conflict of interest.

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