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【 ORIGINAL ARTICLE 】

Non-communicable Disease among Homeless Men in Nagoya, Japan: Relationship between Metabolic Abnormalities and Sociodemographic Backgrounds

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Abstract:

Objective To examine the degree of metabolic abnormalities and their association with the sociodemographic background or mental illness/cognitive disability among homeless men in Nagoya, Japan.

Methods We interviewed 106 homeless men (aged 54.2±12.7 years) and measured their metabolic parameters. Mental illness and cognitive disability were diagnosed using the Mini-International Neuropsychiatric Interview and Wechsler Adult Intelligence Scale-III test, respectively. Associations between metabolic abnormalities and the sociodemographic background or mental illness/cognitive disability were analyzed.

Results There were significant correlations of liver dysfunction (AST≥35 IU, ALT≥35 IU, γ-GTP≥75 IU), hypertension [systolic/diastolic blood pressure (BP) ≥140/90 mmHg], and dyslipidemia (HDL <40 mg/dL) with the history/duration of homelessness (over 2 times/year) and residence status (living on the streets). Although the mean body mass index (BMI), BP, HbA1c, and LDL in participants living in temporary residences were similar to those obtained from the general population data from National Health Nutrition Survey (NHNS) 2016, the systolic/diastolic BP in those living on the street was significantly higher than in the general population, and the HDL in those living in temporary residences was significantly lower than in those reported in the NHNS 2016 data. In the group with cognitive disability, the ALT, TG, and BMI values were significantly higher and the HDL level significantly lower in those living in temporary residences than in those living on the streets.

Conclusion Stressful conditions while living on the streets may exacerbate hypertension and liver dysfunction, and unhealthy food habits when living in a temporary residence may exacerbate low HDL levels. In addition, an inability to self-manage due to cognitive disability may increase the ALT, TG, and BMI values. The provision of homeless people with the skills to sustain independent living conditions and ensure a healthy diet is required.

Key words: lifestyle-related disease, hypertension, social support, housing, non-communicable disease

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Introduction

Patients with lifestyle-related diseases frequently have atherosclerosis, which induces various complications, such as coronary artery disease, brain stroke and renal failure following renal infarction; these conditions require more health services and medical expenditure. Although the prevalence of communicable diseases among homeless individuals has been reported previously (1-3) despite limited access to this population, the prevalence of non-communicable diseases in the homeless in Japan has not been elucidated.

Annual health checkups are provided to laborers based on the Occupational Health and Safety Act in Japan because

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most patients with a lifestyle-related disease have no subjective symptoms. When abnormal data are detected at these checkups, medical care supported by national health insurance is recommended by the public health nurse at the individual's worksite. Since homeless people have no occupation or access to national health insurance, they accordingly are unable to receive these health checkups to detect lifestyle-related diseases or medical care covered by national health insurance. In-depth prevalence data concerning non-communicable diseases may provide evidence for developing a support system for homeless people in Japan.

To our knowledge, there has only been one report on the physical disease patterns among the homeless population in Japan (4); the data were based on the entrants' records collected by a rescue institution operated by the Union of Tokyo Metropolis. Cross-sectional physical health data on homeless people have been reported in the United States (5-12), Canada (13), Australia (14) and Europe (15-19) but not in Japan.

In the present study, we conducted a survey among homeless men in Nagoya, a relatively urban city in Japan, to examine the prevalence of non-communicable diseases and its association with social background factors and mental illness/cognitive disability.

Materials and Methods

Subjects

The subjects in this study were recruited from a meal service area in cooperation with the Sasashima Support Center, a social welfare non-governmental organization, in November, 2014, in Nagoya, Japan. Since the detailed protocol of this cross-sectional survey has been described previously (20), the methodology of this study is described here in brief.

The definition of "literal homelessness" established by the United States Department of Health and Human Services was used in this study. It refers to individuals who lack a fixed, regular and adequate nighttime residence, including those living in supervised publicly or privately operated shelter or places not meant for habitation (e.g., the street, a subway station or a parked car) (21). Although seven women participated, this number was too small to obtain meaningful data. Therefore, the data of only the 106 men with an average age of 54.2±12.7 years (range: 20-78 years) were analyzed in the present study.

Measurements

Data on participants' social backgrounds, including the age, residence status, duration and history of homelessness, alcohol consumption, tobacco smoking status, social support history, pension status, education levels, and gambling status, were obtained through an individual face-to-face interview performed by medical professionals. Alcohol consumption was estimated by the volume consumed that corresponded to 20 g of pure ethanol [an average-sized bottle of beer (5% alcohol): approximately 500 mL, a glass of wine or a cup of sake (14% alcohol): approximately 180 mL, and a glass of double-whisky (43% alcohol): 60 mL (22)].

Psychiatrists conducted semi-structured individual interviews to evaluate the participants' mental status using the Mini-International Neuropsychiatric Interview according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR). Clinical psychologists assessed each participant's current mental capacity and cognitive disability using the Wechsler Adult Intelligence Scale III simplified version and Dairoku et al.'s method (23). Cognitive disability was defined as an Intelligence Quotient <70.

Registered nurses measured the participants' blood pressure (BP), height (Ht) and body weight (BW). The body mass index (BMI) was calculated using the formula of BW (kg) / [Ht (m)]^2. Blood samples were obtained to assess the serum levels of creatinine (Cre), uric acid (UA), hemoglobin A1c (HbA1c), triglyceride (TG), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and γ-glutamyl transpeptidase (γ-GTP). To estimate the kidney function, the estimated glomerular filtration rate (eGFR) (mL/min/1.73 m^2) was calculated as $194\times(age)^{-0.287}\times(Cre)^{-1.094}$. To estimate the glucose tolerance level, we used HbA1c rather than the results of the 75-g oral glucose tolerance test (OGTT) according to the National Health and Nutrition Survey (NHNS), Japan (22); this was to minimize the participants' burden that might be incurred with a 75-g OGTT procedure, which involves fasting for more than 12 hours, undergoing blood sampling 4 times and abstaining from eating and drinking until the final blood sample is collected.

Associations between the participants' medical data and the sociodemographic background or mental illness/cognitive disability were analyzed.

Statistical analyses

Statistical analyses were performed; multiple regression analyses and an analysis of variance were performed using the JMP® software program, version 10.0.2 (SAS Institute, Tokyo, Japan). The value of each parameter was set as an objective variable, and a fixed set of sources of variation was included as explanatory variables, including residence, duration of homelessness, history of homelessness, pension, education, gambling habit, debt, Intelligence Quotient and mental condition. The association of each source of variation with the objective variable was expressed as a standardized partial regression coefficient corresponding to a partial correlation coefficient between -0.1 and 1.0. Statistical significance was defined when the p value was <0.05.

Ethical considerations

This study was approved by the Ethics Review Committee, Graduate School of Medicine, Gifu University; it con-

Table 1. Socio-demographic Background of Participants.

	Total	(n=106) (%)		Total	(n=106) (%)
Age (years)			Alcohol consumption* (g/day)		
20-29	5	(4.7)	nothing	65	(61.3)
30-39	11	(10.4)	20	2	(1.9)
40-49	22	(20.8)	40	9	(8.5)
50-59	27	(25.5)	60	2	(1.9)
60-69	31	(29.2)	80-100	3	(2.8)
≥70	10	(9.4)	120-200	8	(7.5)
Mental illness cognitive disability			220-400	8	(7.5)
normal	42	(39.6)	>400	9	(8.5)
intellectual disability	19	(17.9)	Smoking (number of cigarette/day)		
mental illness	30	(28.3)	nothing	33	(31.1)
both	15	(14.2)	1-10	26	(24.5)
Residence			11-20	40	(37.7)
street	67	(63.2)	21-30	3	(2.8)
temporary residence	33	(31.1)	>30	4	(3.8)
others	3	(2.8)	Social support history		
unknown	3	(2.8)	(+)	53	(50.0)
Duration of homeless life (years)			(-)	53	(50.0)
≤1	58	(54.7)	Pension		
-2	9	(8.5)	nothing	94	(88.7)
-3	8	(7.5)	Basic pension	4	(3.8)
-4	5	(4.7)	employees' pension	6	(5.7)
-5	6	(5.7)	disability pension	0	(0.0)
-10	13	(12.3)	others	2	(1.9)
≥11	7	(6.6)	unknown	0	(0.0)
Past history of homelessness (times)			Study history		
≤1	63	(59.4)	junior high	48	(46.2)
-2	19	(17.9)	senior high	49	(47.1)
-3	11	(10.4)	college or more	7	(6.7)
-4	3	(2.8)	Gambling		
-5	4	(3.8)	yes	36	(34.0)
-10	4	(3.8)	not now	45	(42.5)
≥11	2	(1.9)	never	25	(23.6)

*Alcohol consumption was estimated by the counts of volume which corresponds with 20 g of pure alcohol; an average-sized bottle of beer (5% alcohol/approximately 500 mL), a glass of wine or a cup of sake (14% alcohol/approximately 180 mL), and a glass of double-whisky (43% alcohol/60 mL).

forms to the provisions of the Declaration of Helsinki (as revised in Fortaleza, Brazil, October 2013). All participants provided their written informed consent. When a participant was considered to require medical treatment or social services, he was referred to appropriate medical institutions or public support offices on humanitarian grounds.

Results

Participants' characteristics

The socio-demographic information of the 106 participants is shown in Table 1. All participants were Japanese in ethnicity and nationality. Most of them lived on the street (63.2%, n=67) and had been homeless for less than 1 year (54.7%, n=58). Most (59.4%, n=63) were experiencing homelessness for the first time and had no alcohol drinking habit (61.3%, n=65). Although 53 participants (50.0%) were on social support or had received it in the past, 94 (88.7%) were not receiving any pensions. Of the 106 participants, 45 (42.4%) were diagnosed with a mental illness, including schizophrenia, mood disorders, anxiety disorders, personality disorders and alcohol dependence and/or abuse; 34 (32%) were diagnosed with a cognitive disability; 15 (14.2%) were diagnosed with both a mental illness and cognitive disability; and the remaining 42 had neither a mental illness nor cognitive disability, as reported previously (20).

The correlation of the sociodemographic background and the health data in homeless men

The correlation between the sociodemographic background characteristics of [1] age (<60 and ≥60 years old), [2] mental illness/cognitive disability (positive and negative), [3] residence (street and others), [4] duration of homelessness (<2 and ≥2 years), [5] history of homelessness (no or yes), [6] alcohol consumption (no or yes), [7] tobacco

smoking (no or yes), [8] gambling (no or yes), [9] social support history (no or yes), [10] pension (no or yes) and [11] education level (less than senior high school or other) and health data, including obesity (BMI≥25), hypertension (systolic BP≥140 or diastolic BP≥90), kidney dysfunction (eGFR<60), hyperuricemia (UA≥8.0), diabetes (HbA1c≥6.0), dyslipidemia (TG≥150, HDL<40, or LDL≥140) and liver dysfunction (AST≥35, ALT≥35, or γ-GTP≥75), was analyzed by a multiple regression analysis. There were significant correlations between the AST (≥35), ALT (≥35) and γ-GTP (≥75) levels and a previous history of homelessness. There was also a significant correlation between the γ-GTP level (≥75) and duration of homelessness (≥2 years). There was a significant negative correlation between the HDL level (<40) and residence status (living on the streets). Both systolic and diastolic hypertension had significant correlations with the residence status (living on the streets) and a history of homelessness. Since there were no significant correlations between the BMI (≥25), eGFR (<60), UA (≥8.0), HbA1c (≥6.0), TG (≥150) or LDL (≥140) values and the sociodemographic background ([1] to [11]), only the results of the multiple regression analysis between AST, ALT, γ-GTP, HDL or systolic/diastolic blood pressure and sociodemographic background characteristics are presented in Fig. 1.

Effect of residence status on the health data in groups with/without cognitive disability and/or mental illness

The mean and standard deviation (SD) of the health data comparing living on the streets and in a temporary residence among individuals with/without cognitive disability and/or mental illness were analyzed. The mean data of those living on the streets were set at 100%, and the percent differences from the mean data of those living in temporary residences are presented in Fig. 2.

In the group with mental illness, the systolic/diastolic BP and γ-GTP values were significantly higher in those living on the streets than in those with a temporary residence. In the group without cognitive disability or mental illness, the systolic/diastolic BP was significantly higher in those living on the streets than in those with a temporary residence. In the group with both cognitive disability and mental illness, there were no significant differences in health data between those living on the streets and those with a temporary residence. In contrast, in the group with cognitive disability, the ALT, TG and BMI values were significantly higher while the HDL was significantly lower in those living in a temporary residence than in those living on the streets.

Average health data among those living on the streets or in a temporary residence compared with the data of the general population from NHNS 2016, Japan

Since the mean±SD data of the BMI (20-69 years), BP (40-89 years), HbA1c (50-59 years) and LDL/HDL (40-79 years) in the general population were available from NHNS 2016, Japan (22), the mean±SD data of participants living on the streets or in a temporary residence were compared with the NHNS 2016 data. The mean data of those living on the streets were set at 100%, and the percent differences from the mean data of those living in temporary residences and the NHNS 2016 data are presented in Table 2.

The average BMI, BP, HbA1c and LDL values of those living in temporary residences were similar to those of the general population. However, the systolic/diastolic BP in those living on the streets was significantly higher than in those living in temporary residences. In contrast, the HDL level in those living on the streets was not markedly different from that in the general population; however, this value was significantly lower in those living in temporary residences than in those living on the streets.

Discussion

Homelessness is an independent risk factor for death from specific causes; the mortality (24) rate seems to be limited to substance abuse and this increase is even seen even in countries with a good social safety net (25). Homeless people have a high rate of hospitalization, emergency department visits (26), admission to intensive-care units and hospital mortality despite similar comorbidities and illness severity (27). However, there are few reports describing the physical and mental health status of the homeless along with their socio-demographic background characteristics. Although Tsai et al. presented the first epidemiological survey of lifetime homelessness among a nationally representative sample of veterans in the United States (28), they did not examine the physical condition of the participants, including blood sampling data. To our knowledge, this is the first cross-sectional study of the relationship between the non-communicable disease status and the social background, mental illness and cognitive disability status among homeless individuals. This study is also the first survey to describe the physical health status in detail, including metabolic abnormalities or cardiovascular risk factors, in a Japanese homeless population.

Several surveys have shown that homeless people have a relatively high prevalence of cardiovascular risks, including hyperlipidemia (5, 7, 13, 29), hypertension (5, 7, 10-13, 30), obesity (5, 7-9, 19, 31), diabetes (7, 10, 13, 15, 17), smoking (7, 29-31) and metabolic syndrome (14, 17). The direct relationship between the cardiovascular risk parameters and homelessness has been unclear because the actual laboratory data were within the normal ranges (16) or less than in the general population (29). We showed that there were significant correlations between liver dysfunction and being homeless for ≥2 years or having a history of homelessness. Living on the streets and having a history of homelessness were significantly correlated with systolic/diastolic hypertension. The residence status had a significant negative correlation with the HDL levels (Fig. 1). Harsh conditions, such as living on the streets with exacerbated and neglected hyperten-

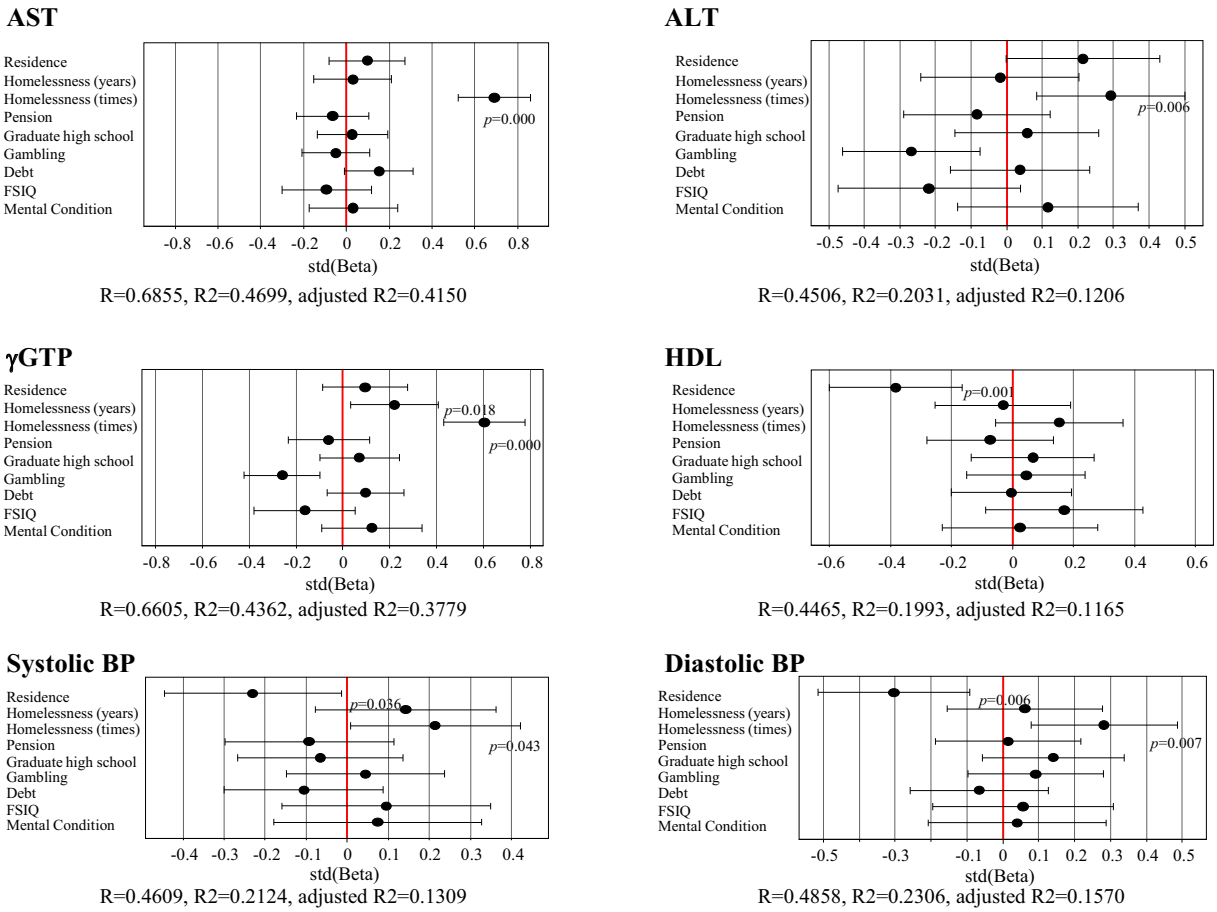

Figure 1. The correlation between the socio-demographic background and health data in homeless men (n=106). Multiple regression analyses and an analysis of variance were performed. The value of each parameter was set as an objective variable, and a fixed set of sources of variation was included as explanatory variables, including residence, duration of homelessness (years), history of homelessness (times), pension, education level (graduated high school), gambling habit, debt, FSIQ and mental condition (cognitive disability and/or mental illness). The association of each source of variation with the objective variable was expressed as a standardized partial regression coefficient corresponding to a partial correlation coefficient between -0.1 and 1.0. Statistical significance was defined when the p value was <0.05. Since there were no significant correlations between the BMI (≥25), eGFR (<60), UA (≥8.0), HbA1c (≥6.0), TG (≥150), or LDL (≥140) values and sociodemographic backgrounds, only the results for the multiple regression analysis between the AST, ALT, γ-GTP and HDL values and the systolic/diastolic BP were presented. ALT: alanine aminotransferase, AST: aspartate aminotransferase, BMI: body mass index, BP: blood pressure, eGFR: estimated glomerular filtration rate, FSIQ: full-scale intelligence quotient, γ-GTP: gamma-glutamyl transferase, HbAlc: hemoglobin A1c, HDL: high-density lipoprotein, LDL: low-density lipoprotein, TG: triglyceride, UA: uric acid

sion and liver dysfunction, might increase the risk of non-communicable diseases. However, having a temporary residence may exacerbate the decrease in the HDL levels, which might increase the risk of non-communicable diseases.

In the group without cognitive disability/mental illness, the average systolic/diastolic BP was significantly higher among those living on the streets than in those with temporary residence (Fig. 2). Since homelessness in this group without cognitive disability/mental illness was mainly due to socioeconomical reasons (32), the stressful and risky environment of street life might have worsened their hypertension, suggesting that housing support would protect homeless individuals without cognitive disability/mental illness from hypertension. In the group with mental illness, not only the average systolic/diastolic BP but also the γ-GTP levels were significantly lower in those with a temporary residence than in those living on the streets. Interventions to improve the housing status may be effective for preventing hypertension and liver dysfunction in homeless with mental illness as well, which suggests that housing support may relieve their fear/anxiety and improve their lifestyle, as demonstrated by Fitzpatrick-Lewis et al. (33). However, there were no significant differences in the health data between those living on the streets and those with a temporary resi-

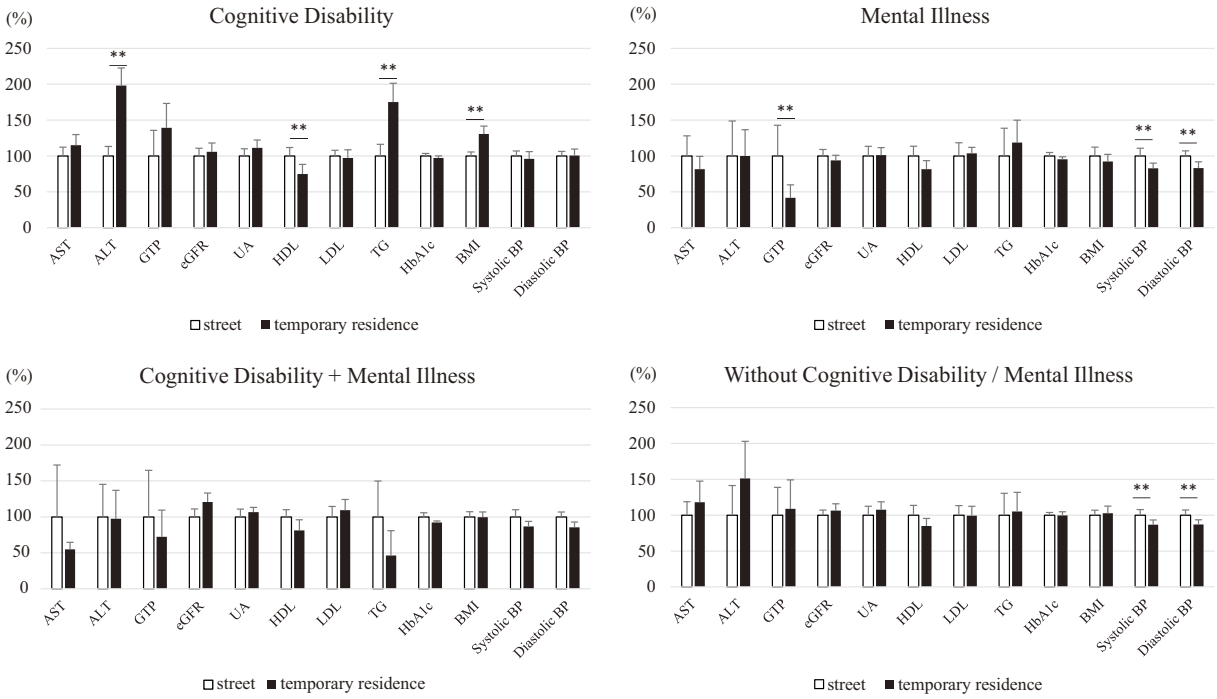

Figure 2. Effect of the residence status on the health data in individuals with/without cognitive disability and/or mental illness. The mean±SD of health data of street-living (□) and temporary resident (■) homeless men who participated in this study with/without cognitive disability and/or mental illness are shown. The mean data of those living on the streets were set at 100%, and the percent differences from the mean data of those living in temporary residences were plotted. *p<0.05, **p<0.01 (analysis of variance). ALT: alanine aminotransferase, AST: aspartate aminotransferase, BMI: body mass index, BP: blood pressure, eGFR: estimated glomerular filtration rate, GTP: gamma-glutamyl transferase, HbA1c: hemoglobin A1c, HDL: high-density lipoprotein, LDL: low-density lipoprotein, SD: standard deviation, TG: triglyceride, UA: uric acid

Table 2. Average Health Data in Homeless with Street Living or Temporary Residence and Data of NHNS 2016 Japan.

	homeless				reference	
	street living (%)		temporary residence (%)		NHNS 2016 (%)	
BMI (kg/m^2)	23.4±4.4	(100±9.4)	24.1±4.9	(103±10.2)	23.8±3.3	(102±6.9)
sysytolic BP (mmHg)	150.2±28.2	(100±9.4)	129.9±19.6	(86±7.5)**	136.1±15.0	(91±5.5)
diastolic BP (mmHg)	92.9±13.6	(100±7.3)	81.5±12.2	(88±7.5)**	81.5±10.0	(88±6.1)
HbA1c (%)	5.7±0.5	(100±4.4)	5.5±0.5	(96±4.5)	5.7±0.6	(100±5.3)
LDL (mg/dL)	115.4±33.1	(100±14.3)	117.3±26.5	(102±11.3)	117.0±26.4	(101±11.3)
HDL (mg/dL)	55.7±14.9	(100±13.4)	45.5±10.9	(82±12.0)**	57.0±14.2	(102±12.5)

Mean±standard deviation (SD) of health data including body mass index (BMI), sysytolic blood pressure (BP), diastolic BP, hemoglobin A1c (HbA1c), low-density lipoprotein choresterol (LDL), and high-density lipoprotein choresterol (HDL) in street living and temporary resident homeless groups are demonstrated. Mean±SD of health data of the general population avairable from National Health and Nutrition Survey (NHNS) 2016 Japan, BMI (20-69 years), BP (40-89 years), HbA1c (50-59 years), and LDL/HDL (40-79 years), are also shown as a reference. The mean data of street residence were determined as 100% and the percent differences in the data of temporary residence and NHNS 2016 were demonstrated. **p<0.01.

dence in the group with both cognitive disability and mental illness (Fig. 2). Because of their difficulties in managing their health behavior and habits, housing services may not be enough for these individuals to improve their health. They might require not only housing services but also additional social services, including mental care and job-hunting support, depending on the individual's needs. The ALT, TG, BMI and HDL values were significantly worse in those with a temporary residence than in those living on the streets in the group with cognitive disability (Fig. 2). Because of the lack an ability to manage their health on their own, homeless individuals with cognitive disability may overeat at shelters with free food service and become overweight or develop dyslipidemia or liver dysfunction induced by fatty

liver. Smith et al. (34) and Martins et al. (35) reported that homeless individuals have food insecurity with an insufficient intake of vegetables, fruits, dairy, meat and beans; furthermore, they are generally obese or overweight due to the excessive intake of fats. The increase in the affordability and accessibility of healthy food is an appropriate strategy for such individuals, similar to the population-tailored approach, the effectiveness of which was demonstrated by O'Toole et al. (36), as homeless individuals with cognitive disorder might have deficits in the area of health and health behavior, as demonstrated by Wagner et al. (18). Assertive case management with health promotion and education might reduce the rate of lifestyle-related disease in homeless people with cognitive disability.

The physical health status of homeless individuals with mental illness such as schizophrenia and depression was previously demonstrated, and the rate of hypertension and hyperlipidemia were similar to or less than those in the general population (37-40). In the present study, we clearly showed that the average health data, except for the HDL, in individuals with a temporary residence were similar to those in the general population, with the HDL being significantly lower than that in the general population. We suspect that having a residence can maintain the health data of homeless individuals at similar levels as in the general population; however, non-diverse and high-energy meals, such as beef bowl (a bowl of rice topped with cooked beef and onions), which is the standard menu served at temporary residences, may reduce the HDL levels. In contrast, the average systolic/diastolic BP was significantly higher in those living on the streets than in those with a temporary residence and the general population (Table 2). This indicates that living on the streets induces hypertension, as previously reported by Edidin et al (41). Adequate support is required to reduce chronic stress and feelings of deprivation and to prevent hypertension in the homeless.

Housing services might not be enough for the prevention of non-communicable diseases, as HDL levels may increase with the provision of housing services, which are speculated to coincide with food habit changes, including over-eating and poorly balanced nutrition. Two systematic reviews provided evidence concerning interventions to improve the health of homeless individuals (33, 42). One showed that abstinence-dependent housing and provision of housing were more effective in improving psychiatric outcomes than non-abstinence dependent housing or no housing (33). That review also showed that health promotion programs were effective in reducing risk behavior in the homeless (33). Another showed that coordinated treatment programs for homeless individuals with mental illness usually resulted in improved health outcomes (42). Based on these findings, housing provision and improving food habits might be effective in preventing non-communicable diseases in homeless individuals.

This study had one main limitation. We conducted a cross-sectional single-day survey, and participants were recruited from a single site. Therefore, we were unable to observe any changes in the prevalence or severity of non-communicable diseases over time. To overcome this limitation, an additional follow-up study would be required.

We demonstrated that living on the streets and frequent/long periods of homelessness may induce hypertension and liver dysfunction; housing support may protect the homeless from these health damages. In contrast, temporary residence may decrease the HDL levels in the homeless and induce overeating, resulting in excessive weight, dyslipidemia and fatty liver among homeless men with cognitive disability. To reduce the health risks in this population, support is needed to help them sustain independent housing and achieve access to healthy food.

The authors state that they have no Conflict of Interest (COI).

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