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ORIGINAL ARTICLE

Differences in the local and national prevalences of chronic kidney disease based on annual health check program data

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Abstract

Background Chronic kidney disease (CKD) is now recognized as a global public health problem, and evaluating the prevalence of CKD at the local level is important and helpful for assessing health care needs and targeted interventions. To assess the current picture concerning CKD in a local area, local and national prevalences of CKD were compared by calculating standardized rate ratios (SRRs) and confidence intervals (CIs).

Methods For the national prevalence of CKD, the data from a previous report that showed age- and sex-specific prevalence of each stage of CKD on the basis of a large dataset from the Japanese annual health check program were used. Using annual health check program data in Sado City, the SRRs and CIs were calculated.

Results The SRRs were 0.70 for males and 0.60 for females, indicating that Sado City had a 30 % lower prevalence of CKD for males and a 40 % lower for females than the national average. The 95 % CIs of the SRRs were calculated as 0.64–0.72 for males and 0.55–0.64 for females. Thus, the prevalence of CKD for both males and females in Sado City is significantly lower than the national average for Japan.

Conclusions Because this methodology adjusts for age and sex, it can serve as a useful tool to assess the current picture related to CKD in a local area. We believe that this could be an important step for improving local care to prevent the development of CKD.

Keywords Chronic kidney disease · Confidence intervals · General population · Local area level · Prevalence

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Introduction

Approximately 13.3 million people are estimated to have chronic kidney disease (CKD) in Japan [1]. Because patients with CKD are a high-risk population not only for reaching end-stage renal disease (ESRD) but also for cardiovascular disease and all-cause mortality [2, 3], it is a public health problem of growing importance. In addition, increasing numbers of ESRD patients pose a serious economic threat to local governments because the cost of ESRD treatment is high.

CKD is an increasingly prevalent problem, especially in societies with an aging population [1]. Sado City, an island located in the Sea of Japan off the coast of Niigata Prefecture, is one of the areas with the most rapidly aging population in Japan. More than 35 % of the population is >65 years, of whom half are >75 years. This proportion of elderly is almost equal to the population projection in Japan in 2039 [4]. There is a compelling need for effective strategies against CKD. To prevent the development of CKD and its progression to ESRD, evaluation of the prevalence of CKD at a local level is important for assessing the needs for health care and targeted interventions.

In the present study, to assess the current status of CKD in Sado City, the local and national prevalences of CKD were compared by determining standardized rate ratios (SRRs) and confidence intervals (CIs).

Methods

The prevalence of CKD was defined as a glomerular filtration rate (GFR) <60 ml/min/1.73 m^2 as calculated using the estimated GFR (eGFR) formula for Japanese persons as below [5].

$$\mathrm{eGFR} = 194 \times \left(\text{serum creatinine}^{-1.094}\right) \times \left(\text{age}^{-0.287}\right) \times (0.739 \text{ for females})$$

The national prevalence of CKD was determined based on a previous report that showed the age-specific prevalence of CKD stages in both males (Table 1 in [1]) and females (Table 2 in [1]) on the basis of a large dataset from the Japanese annual health check program in 2005 [1]. In this report, the prevalence of CKD was estimated to be about 13 % of the Japanese adult population, approximately 13.3 million people, using these data [1].

To compare the prevalence of CKD at a local level with the national prevalence, the number of patients expected to have CKD was calculated by multiplying the number of males or females in each age group from the target area by the corresponding age- and sex-specific national prevalence. The results for all subgroups by each age and sex were totaled to give the expected number of CKD patients in the target area. Finally, each SRR was calculated as the ratio of the observed to the expected number. The SRR can be interpreted as the relative trend of prevalence of CKD in a local population compared with that of the national population. Of several methods of calculating CIs, the method used in the present study yields fairly accurate results without requiring complex calculations [6, 7] and allows CIs to be determined with a hand calculator.

Calculation of the SRR for Sado City

Data from a Specific Health Checkups and Guidance System (participants aged <75 years) and health checkup programs for the elderly (participants aged >75 years) conducted in Sado City in 2008 were used to calculate the expected number of patients with CKD. The Specific Health Checkups and Guidance System program and health checkup programs for the elderly have been described elsewhere [8]. In brief, participants answered a self-administered questionnaire that covered their medical history, smoking habits, alcohol intake, and exercise pattern. Trained staff then measured the height, weight, blood pressure, and waist circumference of each participant, after which serum and spot urine samples were collected. Although serum creatinine is generally not included in the mandatory items of the Specific Health Checkups and Guidance System of Japan and health checkup programs for the elderly, it is uniquely included in the health check program in Sado City. Serum creatinine was measured using an enzymatic method. The actual number of CKD patients in Sado City was calculated from the data obtained from the program using the eGFR formula. All of the participants remained anonymous and the study was conducted according to Japanese privacy protection laws and the ethical guidelines for epidemiological studies published by the Ministry of Education, Science and Culture and the Ministry of Health, Labor and Welfare in 2005.

All calculations could be performed with a hand calculator. Microsoft Excel (Redmond, WA, USA) was used for easy calculation.

Results

The national prevalences of CKD stratified by age and sex are shown in Table 1 [1]. The overall national prevalence

Table 1 Prevalence of chronic kidney disease (CKD) by age and sex

Age (years)	Males			Females		
	Number of CKD patients	Number of participants	Prevalence of CKD (%)	Number of CKD patients	Number of participants	Prevalence of CKD (%)
20–29	12	9,807	0.12	23	10,457	0.22
30–39	214	23,193	0.92	188	20,924	0.90
40–49	1,449	36,478	3.97	1,340	51,859	2.58
50–59	3,820	51,043	7.48	5,502	80,675	6.82
60–69	9,288	58,640	15.84	12,936	87,521	14.78
70–79	14,041	50,605	27.75	21,437	67,480	31.77
≥80	4,834	10,828	44.64	6,694	14,514	46.12
Total	33,658	240,594	13.99	48,120	333,430	14.43

CKD is defined as an estimated glomerular filtration rate <60 ml/min/1.73 m^2. Reproduced from Imai et al. [1]

was 13.99 % for males and 14.43 % for females. The prevalence of CKD increased with age.

A total of 53,938 residents (male 47 %) aged ≥20 years lived in Sado City as of 1 October 2008. Of these, 3,942 males (16 %) and 5,506 females (19 %) participated in the Japanese specific health check and guidance system in 2008.

The results of the calculations are listed in Table 2. The expected and observed numbers of participants with CKD were 850.2 and 595 for males and 1,211.2 and 722 for females, respectively. The SRRs were 0.70 for males and 0.60 for females, indicating that Sado City had a 30 % lower prevalence of CKD for males and a 40 % lower prevalence for females than that expected if the population had experienced the same age-specific prevalence rates of CKD as the reference population. The 95 % CIs of the SRRs were calculated as 0.64–0.72 for males and 0.55–0.64 for females. The CI provides a plausible range for the true SRR. Since these 95 % CIs for the SRRs did not include 1.0, the null hypothesis of equality between the prevalence of Sado City and the national rate can be rejected at the $P = 0.05$ level. Thus, the prevalences of CKD for both males and females in Sado City are significantly lower than the national average for Japan.

Figure 1 clearly shows that the prevalence of CKD in Sado City was lower than the national average for both males and females by age subgroups.

When the prevalence of CKD was defined as a GFR <50 ml/min/1.73 m^2, the study results remained similar (Tables 3 and 4). The SRR for males and females were 0.71 (95 % CI, 0.62–0.82) and 0.66 (95 % CI, 0.58–0.75), respectively.

Discussion

The present study showed that the prevalence of CKD in Sado City was significantly lower for both males and females than the Japanese national average. This finding was somewhat surprising for health care professionals at Sado City Hall, because they had expected that the proportion of CKD patients would be high. Although we could not clarify the reasons why Sado City had a lower prevalence of CKD than the national average in this study, some lifestyle factors would be associated with the lower prevalence. To try to settle the issue, further study is now underway in cooperation with Sado City Hall. Of course, the screening rate of the health check program might affect these results. In addition, the participants might not have been representative of the general population, since they were generally concerned about their health and were in relatively good condition. However, the national data, upon which the comparisons of ratios were performed, were also based on data from the annual health check program. Although this methodology has limitations, the current picture concerning CKD at the local level could be easily assessed by calculating the SRRs and CIs. In cooperation with Sado City Hall, we plan to increase the screening rate of the health check program and to re-evaluate these calculations in the coming years. Although the data from Sado City were used in the present analysis, any local or regional data could be compared with national data using this method.

From a public health perspective, screening for CKD to determine the prevalence of CKD at a local level is important for assessing the needs for health care and interventions. Because CKD is common, harmful, and treatable [9], the issue of CKD extends beyond a clinical problem addressed only by health care providers to a major public health issue requiring multilevel efforts. Nephrologists need to work with health care professionals in local areas to develop public health approaches to reduce the burden of CKD, and data and information must be provided to health care policy makers so that their decisions will effectively address CKD. In combination with the method we previously reported, which allowed comparison of the local to the national incidence of dialysis patients by determining a standardized incidence ratio and confidence intervals [10], we might be able to comprehensively evaluate local areas for managing CKD. Because the relationship between the prevalence of CKD and the incidence of ESRD is complex [11], estimating both the prevalence of CKD and the incidence of ESRD is required for assessing the current status of CKD.

One advantage of the SRR, which is calculated from the total number, is that age-specific incidence data are not required for its calculation. However, several cautions are needed. First, comparison of the SRRs between different local areas is invalid, because local areas show differences in the structure of their study populations [6, 12]. Second, a relatively small number of participants could potentially have caused the difficulty in detection of the differences, which led to wide confidence intervals. Finally, the national average is just the ‘mean value’ and should not be misinterpreted as a standard of ideal care. We think that the present study is only a first step toward assessing the current status of CKD at a local level, with the next step being a more focused comparison to identify the reasons for local differences.

To determine the prevalence of CKD at a local level, we recommend that serum creatinine be included as a mandatory item of the Specific Health Checkups and Guidance System of Japan and health checkup programs for the elderly. Because there are many individuals with CKD who are unaware of this disorder, screening for CKD is one of the most important strategies [13]. The annual health

Table 2 Example of using Table 1 (prevalence of CKD) to compare the local and national prevalences of CKD

Age (years)	Males					Females				
	Prevalence of CKD[a]	Number of participants[b]	Expected number of CKD patients[c]	Observed number of CKD patients[d]	SRR (95 % CI)	Prevalence of CKD[a]	Number of participants[e]	Expected number of CKD patients[f]	Observed number of CKD patients[d]	SRR (95 % CI)
20–29	0.12	82	0.1	0	NA	0.22	128	0.3	0	NA
30–39	0.92	142	1.3	0	NA	0.90	377	3.4	0	NA
40–49	3.97	175	6.9	4	0.58 (0.16, 1.48)	2.58	212	5.5	3	0.54 (0.11, 1.60)
50–59	7.48	405	30.3	18	0.59 (0.35, 0.94)	6.82	494	33.7	39	1.16 (0.82, 1.58)
60–69	15.84	1,217	192.8	165	0.86 (0.73, 1.00)	14.78	1,695	250.5	161	0.64 (0.55, 0.75)
70–79	27.75	1,408	390.7	276	0.71 (0.63, 0.80)	31.77	1,957	621.7	264	0.42 (0.38, 0.48)
≥80	44.64	511	228.1	132	0.58 (0.48, 0.69)	46.12	642	296.1	255	0.86 (0.76, 0.97)
Total	13.99	3,942	850.2	595	0.70 (0.64, 0.76)	14.43	5,506	1,211.2	722	0.60 (0.55, 0.64)

Calculation of the standardized rate ratio (SRR) and 95 % confidence interval (CI)

SRR: observed/expected = 595/850.2 = 0.70 (males); 722/1,211.2 = 0.60 (females)

95 % CI:

$$\text{Lower confidence limit:} = \frac{(\text{Observed})}{(\text{Expected})}\left(1-\frac{1}{9(\text{Observed})}-\frac{1.96}{3\sqrt{(\text{Observed})}}\right)^3$$

$$= \frac{595}{850.2}\left(1-\frac{1}{9\times 595}-\frac{1.96}{3\sqrt{595}}\right)^3 \qquad = \frac{722}{1211.2}\left(1-\frac{1}{9\times 722}-\frac{1.96}{3\sqrt{722}}\right)^3$$

$$= 0.64(\text{males}) \qquad = 0.55(\text{females})$$

$$\text{Upper confidence limit:} = \frac{(\text{Observed}+1)}{(\text{Expected})}\left(1-\frac{1}{9(\text{Observed}+1)}-\frac{1.96}{3\sqrt{(\text{Observed}+1)}}\right)^3$$

$$= \frac{595+1}{850.2}\left(1-\frac{1}{9\times(595+1)}-\frac{1.96}{3\sqrt{(595+1)}}\right)^3 \qquad = \frac{722+1}{1211.2}\left(1-\frac{1}{9\times(722+1)}-\frac{1.96}{3\sqrt{(722+1)}}\right)^3$$

$$= 0.76(\text{males}) \qquad = 0.64(\text{females})$$

NA not available

[a] Percentage rates for the given age and sex subgroup from Table 1

[b] Enter the number of males having the local health check program stratified by age

[c] Calculated as (male prevalence of CKD) × (number of male participants)/100

[d] Enter the number of local CKD patients stratified by age

[e] Enter the number of females in the local health check program stratified by age

[f] Calculated as (female prevalence of CKD) × (number of female participants)/100

checkup is a good opportunity to screen for CKD, because it is performed annually for the Japanese general population. However, serum creatinine is not included in the mandatory items of the Specific Health Checkups and Guidance System of Japan and health checkup programs for the elderly [8]. The present study clearly demonstrated that measuring serum creatinine is useful not only for individual screening for CKD but also for public health evaluation at a local level.

Some limitations of the method used in this study should be discussed. First, CKD was defined from a single creatinine value, and measurements of creatinine can vary among different laboratories. It is not possible to determine whether participants who fulfilled the CKD criteria did so for at least a 3-month period during this study. However, annual repeated measurements in the health check program could solve the problem. Second, the national data were based on data acquired in 2005. With recent improvements in the strategies for managing CKD, the prevalence of CKD might have changed. Furthermore, the national data were reported on the basis of a large dataset from the Japanese annual health check program, but the entire population of Japan was not included. To improve the method described here, nationwide and regularly updated reference data are needed.

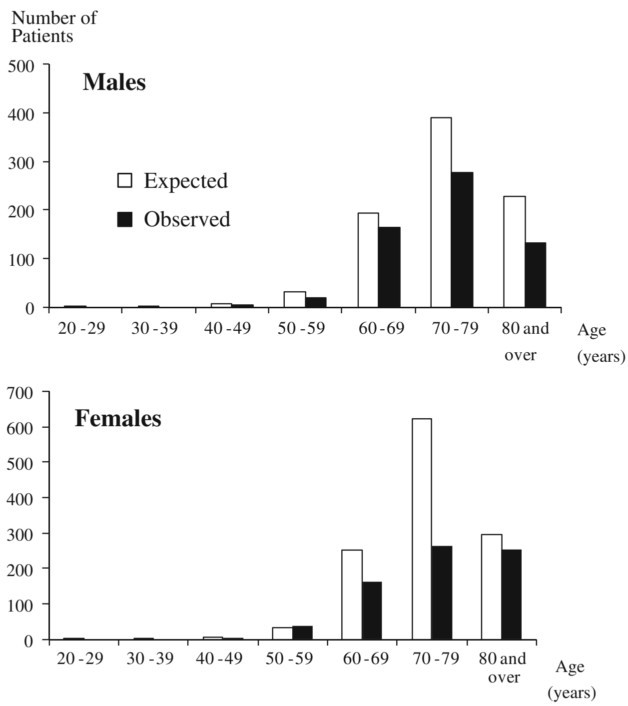

Fig. 1 Observed and expected number of participants with CKD in Sado City; expected: the number of participants predicted to have CKD in Sado City; observed: the actual number of participants with CKD in Sado City

Despite these limitations, this method has several strengths. First, it allows convenient comparison of local data with the national average. Second, the calculation of CIs was simple. Third, as the health check program collects data annually, sequential comparisons are possible. Furthermore, this method allows comparison with data from other countries. The age- and sex-adjusted prevalence of CKD can be calculated for another country and compared with the national prevalence of Japan. Finally, the results of this study may lead to re-evaluation of local efforts to prevent CKD progression.

To improve the method, we have three recommendations. First, the screening rate of the health check program in local areas must be increased. Second, nationwide and regularly updated reference data are needed. Finally, we recommend that serum creatinine should be included as a mandatory item of the Specific Health Checkups and Guidance System of Japan and health checkup programs for the elderly.

Conclusions

A practical method to estimate the number of CKD patients in local areas was presented. This method may be one way

Table 3 Prevalence of chronic kidney disease (CKD) by age and sex

Age (years)	Males			Females		
	Number of CKD patients	Number of participants	Prevalence of CKD (%)	Number of CKD patients	Number of participants	Prevalence of CKD (%)
20–29	7	9,807	0.07	4	10,457	0.04
30–39	27	23,193	0.12	20	20,924	0.10
40–49	159	36,478	0.44	134	51,859	0.26
50–59	611	51,043	1.20	680	80,675	0.84
60–69	2,258	58,640	3.85	2,335	87,521	2.67
70–79	4,572	50,605	9.03	5,578	67,480	8.27
≥80	1,970	10,828	18.19	3,309	14,514	22.80
Total	9,604	240,594	3.99	12,060	333,430	3.62

CKD is defined as an estimated glomerular filtration rate <50 mL/min/1.73 m^2

Reproduced from Imai et al. [1]

Table 4 Example of using Table 3 (prevalence of CKD) to compare the local and national prevalences of CKD

Age (years)	Males					Females				
	Prevalence of CKD (%)	Number of participants	Expected number of CKD patients	Observed number of CKD patients	SRR (95 % CI)	Prevalence of CKD (%)	Number of participants	Expected number of CKD patients	Observed number of CKD patients	SRR (95 % CI)
20–29	0.07	82	0.1	0	NA	0.04	128	0.0	0	NA
30–39	0.12	142	0.2	0	NA	0.10	377	0.4	0	NA
40–49	0.44	175	0.8	0	NA	0.26	212	0.5	1	1.83 (0.05, 10.2)
50–59	1.20	405	4.8	10	2.06 (0.99, 3.79)	0.84	494	4.2	2	0.48 (0.06, 1.74)
60–69	3.85	1,217	46.9	35	0.75 (0.52, 1.04)	2.67	1,695	45.2	51	1.13 (0.84, 1.48)
70–79	9.03	1,408	127.2	73	0.58 (0.45, 0.72)	8.27	1,957	161.8	102	0.63 (0.51, 0.77)
≥80	18.19	511	93.0	77	0.83 (0.65, 1.04)	22.80	642	146.4	81	0.55 (0.44, 0.69)
Total	3.99	3,942	272.9	195	0.71 (0.62, 0.82)	3.62	5,506	358.5	237	0.66 (0.58, 0.75)

CKD is defined as an estimated glomerular filtration rate <50 ml/min/1.73 m^2

SRR standardized rate ratio, *95 % CI* confidence interval, *NA* not available

to provide information that guides us in improving local care to prevent CKD.

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Conflict of interest None.

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