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Epidemiological Study on Reasons for Leg Amputation in Japanese

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Abstract

This study was conducted, with special reference to elucidating the causes for lower limb amputation, which would have the most significant effect on "locomotion", the basis of independence of the aged. The subjects were leg amputees for whom artificial limbs had been fitted financed by various insurance policies in Osaka prefecture. The survey was conducted on 3,138 subjects, from whom acceptable responses were obtained from 1,460 (recovery rate, 46.5%). Questionnaires were mailed to each prospective respondent's home. Among men, occupational accidents were the most frequently cited cause (33.8% of all subjects), followed by traffic accidents, diabetes mellitus, and war injuries. For women, traffic accidents topped the list (33.2%), followed by tumor, diabetes mellitus, and unspecified illnesses. The outstanding differences between men and women were the high incidence of work-related accidents and war injuries cited by the men. Since 1980, the percentage of amputees suffering from diabetes mellitus markedly increased, both among men and women. Outstanding reductions were noted in the incidence of amputation due to occupational accidents among men and traffic accidents among women. Following a peak in the 1950s, the percentage of amputations due to these traumatic accidents gradually decreased. Diabetes mellitus is not only responsible for complications but serves as the major cause for leg amputation, which is a formidable detriment to coping with the activities of daily living. The results of the this study clearly indicated that the prevention of diabetes mellitus is an important objective for improving the QOL and prolonging a healthy life for the aged.

1 Introduction

In the second half of the 20th century, mortality has been reduced in Japan at every age levels; and the mean life expectancy has been extended for reasons such as improved public health services and health care-providing systems, advances in medical technology, and a rise in living standards. More recently, it has been suggested that mere prolongation of life is not enough: one must aim at extending the period during which a person does not have to depend on others for care so that he or she may enjoy an independent and active life, both psychologically and physically. Thus it may be said that the collective goal of the nation for the 21st century is the prolongation of "a healthy life expectancy" or a healthy life with an emphasis on the quality of life (QOL).,[1] For this goal, it is necessary to evaluate those factors that may be responsible for a marked deterioration in the quality of life of the aged: in particular, an examination of these factors that may lead to the amputation of one's extremities, which will affect the activities of the aged most significantly appears very important.

Due to recent dramatic changes in industrial structures and disease patterns due to newly acquired life styles, the causes for amputating extremities are also undergoing marked changes in this country.[2] Consequently, it is expected that there have been notable changes in the incidence of limb amputations, the ages of the patients undergoing the procedure, and sites of amputation. To improve the QOL of the aged amputees, it is deemed appropriate to conduct epidemiological studies, such as detailed investigations on the activities for these amputees and difficulties they face vis-à-vis the social scene.

It is extremely difficult to conduct a survey on the

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physically handicapped, even if not only for medical reasons but also for sociological purposes (including the various aspects of one's life style). Thus reports on amputees are very scarce in Japan and there have been practically no surveys conducted on a nationwide scale. In western countries, a number of studies have been conducted on amputees.[3-9] In Denmark, in particular, a system for registering amputees has been implemented since 1972 and substantial epidemiological findings on amputation have been collected. This information was reflected in the public policies for medical care and welfare of the amputees, thus contributing to an improved QOL for these individuals.[10]

As stated above, there is an extreme paucity of epidemiological studies on amputees in Japan. Among the scarce basic data, there is a survey that was conducted by the Japanese Society of Rehabilitation Medicine to promote standardization of welfare-related equipment.[11] It was conducted in 6 areas (such as Tokyo and Miyagi Prefecture) on amputees in 1976 based on the diagnostic certificates issued when the patients applied for official records on physical handicaps. The survey was in the form of interviews: data was collected on physical symptoms, the use of artificial arms or legs, and societal participation, such as occupational rehabilitation. Included were 441 subjects with amputated arms and 953 with amputated legs. This survey was conducted more than a quarter of a century ago and the deterioration in the physical conditions of the amputees due to aging and the changes in societal conditions are limited to mere conjecture: the material is hardly sufficient if one is seeking a basis to improve the QOL of the aged amputees. There has been no available data to learn the status of the aged leg amputees that are increasing in number in the modern aging society.

In response to the situation described above, the present study was conducted, with special reference to elucidating the causes for lower limb amputation, which would have the most significant effect on "locomotion", the basis of independence of the aged. The study was conducted with a specific purpose: to compile basic data so that the QOL of the aged could be improved; and to prolong their healthy life.

2 Method and Subjects

2.1 Subjects

All of Osaka Prefecture was designated as the area where the survey was to be conducted. The subjects were leg amputees for whom artificial limbs had been fitted financed by various insurance policies, such as Workmen's Compensation, Welfare Pension Insurance, and the National Health Insurance.

The survey was conducted on 3,138 subjects, from whom acceptable responses were obtained from 1,460 (recovery rate, 46.5%). The respondents included 1,132 men (77.5%) and 318 women (21.8%). Ten (0.7%) did not specify gender in their responses.

2.2 Survey methods

Questionnaires were mailed to each prospective respondent's home. A multiple choice format was adopted to obtain responses to questions on physical characteristics and social activities of each leg amputee. The completed sheet was to be returned in the self-addressed envelope that was included in the package. If the respondent was unable to respond by himself (either too old or too young), his custodian was expected to fill out the form for him.

Prior to the final survey, a thorough preliminary survey was conducted to evaluate the survey methods, such as the selection of subjects, distribution and recovery of survey sheets, number of survey items, the details of survey items, and the format for listing questions. Based on this preliminary survey, improvements were made to the final survey. About 80% of the responses were received by April 3rd.

Among the questionnaires that were returned, the following were treated as a "no response": 1) no entries made by the respondent; 2) inconsistent data (e.g., the date of amputation precedes the birth date); 3) multiple choices were made when only one was to be selected; 4) the writing was ambiguous or decipherable. In addition, when "illness" was marked as the cause of amputation but no specific disease was named, the response was treated as "disease name unspecified".

To protect the respondent's human rights, the purpose of this study was clearly stated on the survey sheet. Also stated: the results of this study will not be used for purposes other than to improve the health care and QOL of amputees; participation in the study is completely voluntary; personal privacy will be thoroughly maintained; and those in charge of the survey are ready to respond to any questions from the prospective respondents.

To protect the privacy of the respondents, statistical analyses were conducted by using a code for each individual. This precluded identifying an individual after the restrictions on the survey data are lifted or the study results are published.

2.3 Survey items

The questionnaire contained the following 9 items: 1) gender; 2) age; 3) date of initial amputation of leg; 4) reason for amputation; 5) anatomical site of amputation, 6) condition of amputation stump (pain, wound, rash); 7) presence or absence of phantom limb or phantom pain; 8) use of an artificial leg (number of artificial legs owned, training to use artificial leg, number of hours using it, extent

of satisfaction, and type of shoes used); 9) on the capacity to carry out daily activities (e.g., license to drive an automobile, commuting, and shopping). The respondent was asked to select one from 2 to 5 possible responses.

For age, the respondent was asked to enter his birth date, which was later confirmed.

For the time of amputation, the date was entered individually for each leg (for double amputees) and for those who had undergone amputation more than once were asked to enter each date.

For the cause of amputation, one of the following 5 was selected: 1. occupational accident, 2. traffic accident, 3. war injury (sustained on the battle ground or as a civilian casualty), 4. electrocution, 5. illness [(1) diabetes mellitus, (2) tumor, (3) burn, (4) congenital abnormality, (5) gangrene or necrosis, (6) frostbite, (7) others].

To specify the anatomical site of amputation, the respondent was asked to draw a line at the corresponding place on the drawing of a leg in the questionnaire.

In this study, only items 1) through 5) were analyzed. Therefore detailed descriptions on questions from 6) "condition of the amputation stump" through 9) "on the capacity to carry out daily activities" were omitted.

2.4 Statistical analysis

For the statistical analysis, Macintosh Statview ver.5.0 was used. For the analytical method, the Chi 2 and unpaired-t tests were conducted.[12] The level of significance was set at $p<0.05$.

3 Results

3.1 General description of the leg amputees

The men to women ratio was 3.6:1, with the dominance by men being statistically significant. The mean age of the subjects was 60.0 ± 15.5 years, with a range of 2 to 95 years (the distribution of age groups is shown in Fig. 1). The percentage of subjects increases with age, with the largest (both sexes) in their 70s. Those in their 70s and 60s were 57.9% of all subjects.

Fig. 2 shows a breakdown of the sites of amputation: 93.1% suffered amputation of one leg, 6.9% both legs. Among those with unilateral amputated, amputation of the left leg occurred slightly more often. Amputation had been performed most frequently below the knee (right, 22.8%; left, 25.8%), followed by thigh amputation, foot amputation, hip disarticulation, and knee disarticulation, in descending order. Among the bilateral amputees, bilateral below the knee amputation was most common (2.4%), followed by bilateral foot amputation (1.2%). (Data was unshown.)

3.2 Relationship between causes for leg amputation and related factors

Fig. 3 shows a breakdown of the causes for leg amputation of the subjects of this study. Among men, occupational accidents were the most frequently cited cause (33.8% of all subjects), followed by traffic accidents, diabetes mellitus, and war injuries. For women, traffic accidents topped the list (33.2%), followed by tumor, diabetes mellitus, and unspecified illnesses. The outstanding differences between men and women were the high incidence of occupational accidents and war injuries cited by the men.

Fig. 4 shows the percentage for the major causes (such as occupational accidents, traffic accidents, and diabetes mellitus) that led to amputation. Since 1980, the percentage of amputees suffering from diabetes mellitus markedly increased, both among men and women. Outstanding reductions were noted in the incidence of amputation due to occupational accidents among men and traffic accidents among women. Following a peak in the 1950s, the percentage of amputations due to these traumatic accidents gradually decreased. This is a retrospective study that started in 1998. It is not a survey on the cause of amputations that includes data for those leg amputees who

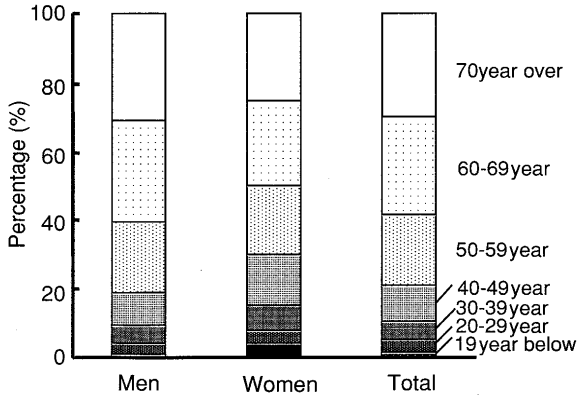
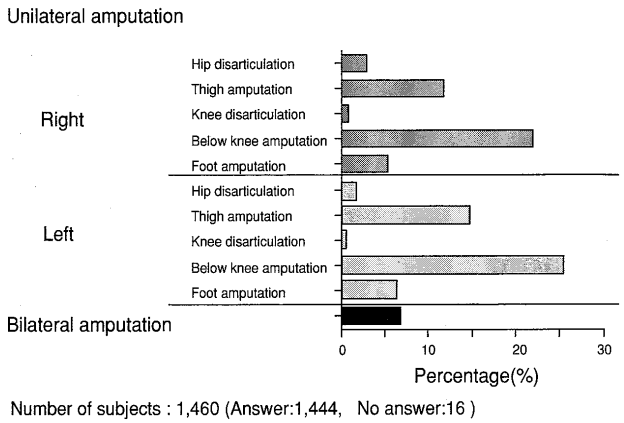


Fig. 1 Age distribution in the leg amptuees



Number of subjects : 1,460 (Answer:1,444, No answer:16)

Fig. 2 Breakdown of sites of amputation

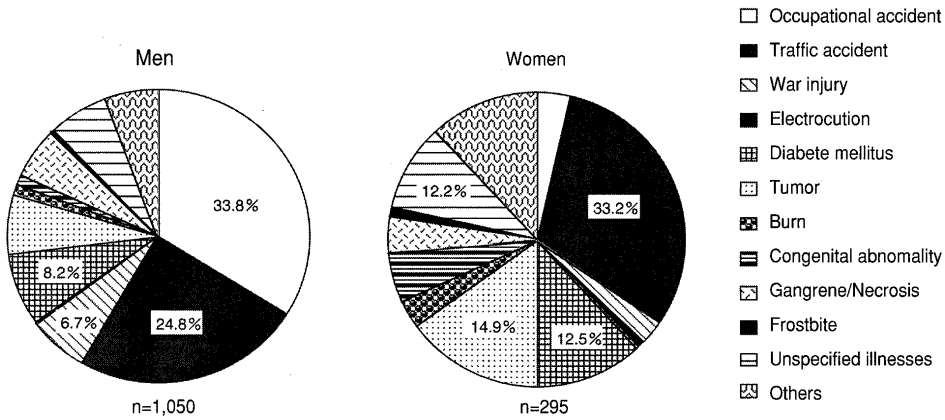


Fig. 3 Breakdown of causes for leg amputation

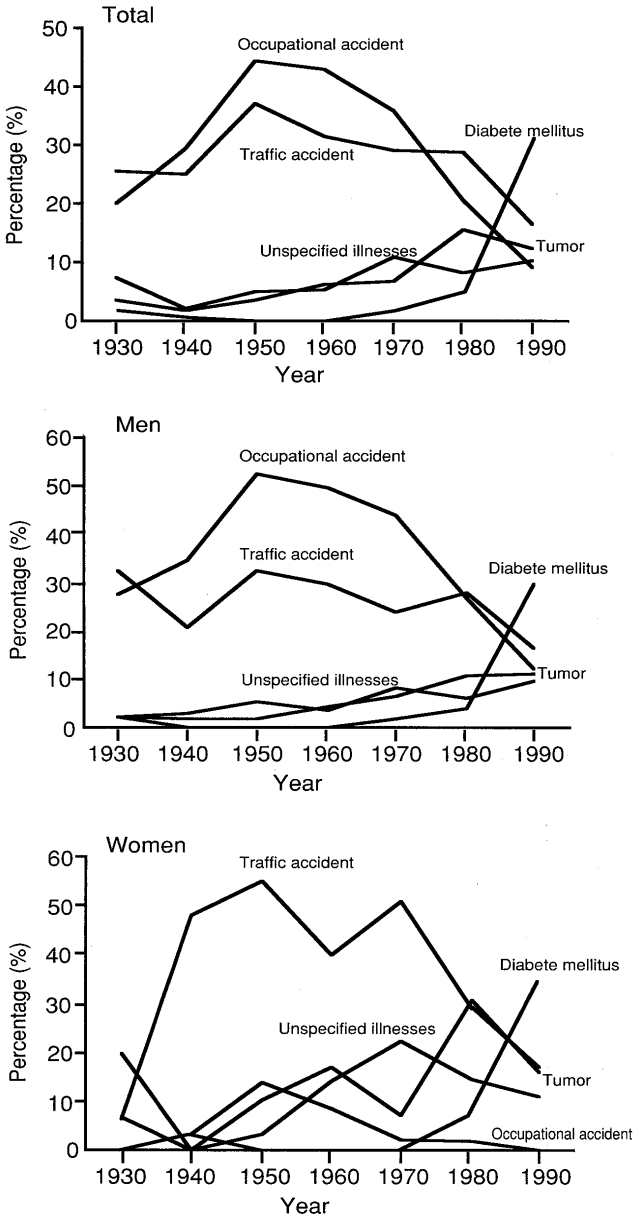


Fig. 4 Annual Change in the percentage for the initial major amputation causes

expired in previous years. One should note that these results do not necessarily represent exact annual changes in the causes for amputation.

Table 1 shows the age distribution at the initial amputation by cause for leg amputation. Among men, traffic accidents accounted most frequently for the initial leg amputation in the age group of 0 to 19 years. Occupational accidents were cited most frequently for those in the 20 to 39 and 40 to 59 groups: and diabetes mellitus was the most frequent cause for those in those of 60 years and older group. Among women, traffic accidents were the most frequently cited cause of initial leg amputation for those in the 0 to 19, 20 to 39, and 40 to 59 groups. Like the men in the equivalent age range, diabetes mellitus was the leading cause for those in whom the initial amputation occurred at age 60 or older. It was concluded that the major cause for leg amputation was traumatic accidents for both men and women between the ages of 19 to 59; and for those over 60 years, the numbers were higher for diabetes mellitus.

Table 2 shows means ± standard deviation for the current age, age at the initial amputation, and the time that elapsed since amputation, all grouped by cause for amputation. The mean age at the initial amputation for the entire group was 34.5 ± 20.0. The initial age at amputation was highest for both men and women patients with diabetes mellitus, followed by gangrene and necrosis, then other unspecified illnesses. It was shown that amputations were conducted on the older population because of illnesses. The age at the initial amputation was lower when the procedure was conducted for traumatic causes (not related to illnesses but excluding congenital conditions), such as burns, war injuries, occupational accidents, and traffic accidents. The mean time that elapsed after the leg amputation was 25.8 ± 18.6 years, with the longest being 86 years. The elapsed time was longest (over 50 years) for amputations due to war injuries, for both men and women. Conversely, the shortest elapsed time (5 to 6 years) was found among men and

Table 1 The age distribution at the initial amputation by causes for leg amputation

Age group	Occupational accident	Traffic accident	War injury	Electrocution	Diabete mellitus	Tumor	Burn	Congenital abnormality	Gangrene Necros	Frostbite	Unspecified illnesses	Others
Total												
0-19	71(20.0)	160(45.1)	24(6.8)	0(0.0)	2(0.5)	31(8.7)	13(3.7)	10(2.8)	7(2.0)	2(0.5)	17(4.8)	18(5.1)
20-39	189(40.6)	122(26.2)	51(11.0)	2(0.4)	3(0.6)	31(6.7)	5(1.1)	0(0.0)	11(2.4)	4(0.9)	25(5.4)	22(4.7)
40-59	89(25.6)	56(16.1)	1(0.3)	1(0.3)	56(16.1)	35(10.1)	4(1.1)	0(0.0)	36(10.3)	1(0.3)	40(11.5)	29(8.3)
60over	16(9.0)	20(11.3)	3(1.7)	0(0.0)	62(35.0)	18(10.2)	1(0.6)	0(0.0)	15(8.5)	0(0.0)	20(11.3)	22(12.4)
Men												
0-19	67(25.7)	124(47.5)	17(6.5)	0(0.0)	1(0.4)	21(8.0)	6(2.3)	3(1.1)	5(1.9)	1(0.4)	8(3.1)	8(3.1)
20-39	186(47.2)	85(21.6)	49(12.4)	1(0.3)	2(0.5)	21(5.3)	5(1.3)	0(0.0)	11(2.8)	2(0.5)	18(4.6)	14(3.6)
40-59	86(32.6)	35(13.2)	1(0.4)	1(0.4)	41(15.5)	18(6.8)	2(0.8)	0(0.0)	32(12.1)	1(0.4)	25(9.5)	22(8.3)
60over	16(12.2)	16(12.2)	3(2.3)	0(0.0)	42(32.1)	11(8.4)	1(0.8)	0(0.0)	10(7.6)	0(0.0)	15(11.4)	17(13.0)
Women												
0-19	4(4.3)	36(38.3)	7(7.4)	0(0.0)	1(1.1)	10(10.6)	7(7.4)	7(7.4)	2(2.2)	1(1.1)	9(9.6)	10(10.6)
20-39	3(4.2)	37(52.1)	2(2.8)	1(1.4)	1(1.4)	10(14.1)	0(0.0)	0(0.0)	0(0.0)	2(2.8)	7(9.9)	8(11.3)
40-59	3(3.6)	21(25.0)	0(0.0)	0(0.0)	15(17.8)	17(20.2)	2(2.4)	0(0.0)	4(4.8)	0(0.0)	15(17.9)	7(8.3)
60over	0(0.0)	4(8.7)	0(0.0)	0(0.0)	20(43.4)	7(15.2)	0(0.0)	0(0.0)	5(10.9)	0(0.0)	5(10.9)	5(10.9)

( ):percentage

Table 2 Current age, age at the initial leg amputation, and the time that elapsed following amputation by the cause for amputation

Amputation causes	Current age (yeras)	Initial leg amputation age (years)	Amputation term (years)
Total			
Occupational accident	63.4±10.8	31.7±14.2	31.9±15.3
Traffic accident	54.7±14.8	26.0±17.4	28.7±17.4
War injury	74.7± 7.1	22.5±13.3	52.1±10.4
Electrocution	44.8±28.9	38.3±12.7	19.3±21.5
Diabete mellitus	65.5±10.9	59.6±13.2	5.9± 8.0
Tumor	53.5±19.2	37.2±19.8	16.0±13.5
Burn	52.6±16.8	20.1±23.4	31.7±23.5
Congenital abnormality	28.4±22.3	5.8± 6.2	30.0±21.4
Gangrene/Necrosis	65.7±11.2	46.9±17.1	18.6±14.8
Frostbite	56.3±17.7	27.4±16.9	28.9±25.2
Unspecified illnesses	62.2±14.5	42.0±20.3	19.9±16.1
Others	61.1±14.2	41.5±23.0	19.7±17.9
Men			
Occupational accident	63.4±10.6	31.7±14.1	31.7±15.4
Traffic accident	54.5±15.4	25.6±17.6	28.9±17.8
War injury	76.0± 6.1	24.0±13.3	51.9±11.1
Electric shock	49.0± 7.1	41.5±16.3	7.5± 9.2
Diabete mellitus	65.6±10.6	59.8±12.8	5.7± 7.8
Tumor	52.4±18.7	36.1±19.8	16.3±14.3
Burn	53.3±18.6	24.1±22.4	26.8±23.2
Congenital abnormality	23.4±18.5	8.3±6.7	25.3±19.7
Gangrene/Necrosis	65.0±11.2	45.6±16.3	19.1±13.2
Frostbite	48.5±17.4	27.5±21.4	21.0±28.0
Unspecified illnesses	63.5±13.8	43.9±19.6	19.3±15.5
Others	62.5±13.4	45.1±20.9	17.6±14.9
Women			
Occupational accident	63.3±17.4	27.9±17.2	37.7±11.5
Traffic accident	55.2±13.4	26.9±16.9	28.3±16.4
War injury	64.3± 6.4	11.0± 7.6	53.3± 2.2
Electric shock	40.5±48.8	32.0	43.0
Diabete mellitus	65.1±11.9	58.9±14.2	6.2± 8.4
Tumor	55.1±20.1	39.0±19.9	15.6±12.2
Burn	51.4±14.6	13.9±24.8	39.3±23.1
Congenital abnormality	31.4±24.4	4.7± 6.1	32.0±23.3
Gangrene/Necrosis	69.7±11.0	53.7±20.7	16.0±21.9
Frostbite	66.7±14.2	27.3±13.2	39.3±21.1
Unspecified illnesses	60.0±15.8	38.6±21.2	20.9±17.2
Others	58.3±15.7	34.2±25.7	24.1±22.3

Data are presented as Mean±S.D.

Table 3 The site of amputation by the causes for the surgical procedure

Amputation causes	Amputation location				
	Hip (disarticulatio)	Thigh	Knee (disarticulation)	Below knee	Foot
Total					
Occupational accident	16(4.2)	105(27.5)	17(4.5)	174(45.7)	69(18.1)
Traffic accident	16(4.4)	102(27.9)	21(5.8)	188(51.5)	38(10.4)
War injury	1(1.2)	34(41.5)	3(3.6)	39(47.6)	5(6.1)
Electrocution	0(0.0)	0(0.0)	0(0.0)		0(0.0)
Diabete mellitus	1(0.8)	9(7.0)	13(10.2)	90(70.3)	15(11.7)
Tumor	17(14.4)	62(52.5)	0(0.0)	35(29.7)	4(3.4)
Burn	0(0.0)	5(20.8)	6(25.0)	6(25.0)	7(29.2)
Congenital abnormality	0(0.0)	2(7.2)	1(3.6)	16(57.1)	9(32.1)
Gangrene/Necrosis	1(1.4)	11(15.3)	13(18.1)	42(58.3)	5(6.9)
Frostbite	0(0.0)	0(0.0)	3(42.9)	3(42.9)	1(14.2)
Unspecified illnesses	8(7.5)	36(33.6)	9(8.4)	47(43.9)	7(6.6)
Others	2(2.1)	31(33.0)	10(10.6)	44(46.8)	7(7.5)
Men					
Occupational accident	16(4.3)	104(28.1)	16(4.3)	167(45.2)	67(18.1)
Traffic accident	13(4.9)	77(28.8)	9(3.4)	140(52.4)	28(10.5)
War injury	1(1.4)	32(43.8)	2(2.7)	34(46.6)	4(5.5)
Electrocution	0(0.0)	0(0.0)	0(0.0)	2(100)	0(0.0)
Diabete mellitus	1(1.1)	8(8.9)	10(11.1)	61(67.8)	10(11.1)
Tumor	12(16.9)	39(54.9)	0(0.0)	17(24.0)	3(4.2)
Burn	0(0.0)	3(21.4)	3(21.4)	4(28.6)	4(28.6)
Congenital abnormality	0(0.0)	1(9.1)	1(9.1)	6(54.5)	3(27.3)
Gangrene/Necrosis	1(1.7)	10(16.7)	13(21.7)	34(56.6)	2(3.3)
Frostbite	0(0.0)	0(0.0)	2(50.0)	1(25.0)	1(25.0)
Unspecified illnesses	8(11.6)	21(30.4)	5(7.3)	30(43.5)	5(7.2)
Others	0(0.0)	22(34.4)	7(10.9)	28(43.8)	7(10.9)
Women					
Occupational accident	0(0.0)	1(9.1)	1(9.1)	7(63.6)	2(18.2)
Traffic accident	3(3.1)	25(25.5)	12(12.2)	48(49.0)	10(10.2)
War injury	0(0.0)	2(22.2)	1(11.1)	5(55.6)	1(11.1)
Electrocution	0(0.0)	0(0.0)	0(0.0)	2(100)	0(0.0)
Diabete mellitus	0(0.0)	1(2.6)	3(7.9)	29(76.3)	5(13.2)
Tumor	5(10.7)	23(48.9)	0(0.0)	18(38.3)	1(2.1)
Burn	0(0.0)	2(20.0)	3(30.0)	2(20.0)	3(30.0)
Congenital abnormality	0(0.0)	1(5.9)	0(0.0)	10(58.8)	6(35.3)
Gangrene/Necrosis	0(0.0)	1(8.3)	0(0.0)	8(66.7)	3(25.0)
Frostbite	0(0.0)	0(0.0)	1(33.3)	2(66.7)	0(0.0)
Unspecified illnesses	0(0.0)	15(39.5)	4(10.5)	17(44.7)	2(5.3)
Others	2(6.7)	9(30.0)	3(10.0)	16(53.3)	0(0.0)

( ): percentage

women who suffered from diabetes mellitus.

Table 3 shows the site of amputation by the causes for this surgical procedure. For traumatic causes, such as work-related accidents and traffic accidents, amputation involved the entire leg (below knee, above knee, thigh, and knee districulation in descending order). Amputation due to ischemic diseases, such as diabetes mellitus, gangrene, and necrosis, occurred most frequently below the knee (66.2%). Compared with other causes, the frequency of amputation of both legs due to ischemic conditions was significantly high ($p < 0.05$). Amputations due to the presence of tumors frequently took place above the knee (hip districulation and amputation at the thigh, 67.9%).

4 Discussion

The mean life expectancy has been extended at a rapid rate in Japan and the number of people over 65 years of age was 21,870,000 in year 2000. The increase in the aged population is currently 17.2%, which is advancing at an accelerated rate. Under this societal condition, our goals should be to expand the so-called "healthy life", i.e., prolong a healthy life for the aged,1 delaying as long as possible the development of the condition that requires extensive nursing care, and supporting their positive participation in activities at home, in the community, and in the social arena.

To achieve this goal, the most important approach is to prevent the development of factors that may be responsible for significant deterioration in the QOL of the aged. There are a number of specific factors that would be disadvantageous to QOL but none is as irreversible and more serious in affecting one's physical activities than the loss of a limb. Therefore in an effort to find the means to prolong a healthy life, the present study was conducted on the causes for leg amputation that have a grave impact on the deterioration of QOL.

The major causes for leg amputation are generally classified into trauma and illness. With recent dramatic changes in industrial procedures and disease patterns due to new life styles, the cause for leg amputation has been changing notably. Due to reductions in the number of workers engaged in the primary and secondary industries and the concerted efforts by the executive bodies, industries, and workers to improve industrial safety and hygiene, the mortality and morbidity related to work site injuries have been rapidly reduced since 1970. There have also been reductions in the frequency and severity of work-related injuries at work sites employing 100 or more workers.

For the diseases responsible for leg amputation, diabetes mellitus[2] has emerged as a representative of diseases caused by the new life style. The prevalence of diabetes mellitus has been on the rise since around 1965, rose quickly around 1979, and reached 5.3 persons per 1,000 population in 1984. With the recent trend of aging of the society in the background, the incidence of diabetes mellitus is rapidly increasing in those over 65 years of age.

It is extremely important to have a precise understanding of the current status of leg amputees, which is evidently affected by changes in industrial practice and morbidity, not only for primary prevention but also for timely promotion of rehabilitation policies, a tertiary preventive measures against amputation. A survey to gain an accurate insight into these causes will ultimately lead to prolonging a healthy life for the aged.

The men : women ratio for the subjects of this survey, the leg amputees residing in Osaka Prefecture, was 3.6:1. The 1976 report by the Japanese Society of Rehabilitation Medicine[11] gave a ratio of 4.9:1. A study by Nakagawa,[13] et al. that was conducted in 1991 reported a ratio of 4.3:1, which was computed for cases with both arm and leg amputations. At any rate, the sex ratio appears to become less significant as time passes. This may be explained by the fact that the incidences of leg amputation caused by industrial mishaps or traffic accidents, the major causes for amputation among men, are being reduced because of the improved safety at work sites and advances in surgical procedures.

Following a peak in 1961, the morbidity and mortality associated with industrial accidents have continued to decline; and in 1998, overall injuries and morbidity were reduced by 5.4% and 11.3%, respectively, from the previous year. The number of accidents occurring at plants was also lower: by about 30% in 1973 at plants employing 300 or more workers and by about 50% at small plants employing only 1 to 4 workers. These reductions in the number of accidents occurring at industrial plants are most likely to have contributed to the decline in leg amputations, as well as a near normalized sex ratio among the amputees.

The results of this survey showed that about 60% of the subjects were over 60 years of age. Compared with earlier reports, the leg amputees of this survey were older. Injuries due to work-related and similar accidents that often affected younger people have been reduced; and leg amputation due to diabetes mellitus, which affects middle-aged to older patients is on the rise. Both of these account for the older age of leg amputees. Nakagawa, et al.,[13] who conducted a survey on 688 leg amputees over a period of 20 years between 1969 and 1988, reported that the number of individuals undergoing amputation between the ages of 20 and 39 was decreasing while a notable increase was found in those undergoing the procedure who were 60 or older. These researchers divided the 20-year survey period into 4-year sub-periods and investigated the incidence of

amputation during each sub-period. They stated that in the final sub-period (1985 to 1988), the amputees over65 accounted for 43% of the entire amputee population. The results of this survey also showed that the proportion of those over 60 was 57.9%. A trend was recognized in Japan: the age at which legs were amputated shifted from the younger to the older population, as in the western world.

There are several reports on the causes and their changes for leg amputations. For trauma-related amputation, such as accidents at work sites and in traffic accidents, and amputation necessitated by ischemic conditions, such as diabetes mellitus and necrosis, there is a study by Okubo, et al.,[14] who studied the causes for leg amputations of individuals who visited the Osaka City Counseling Service for Rehabilitation of the Physically Disabled. They found that amputation due to ischemic diseases was 10.3% of the amputee population. Akashi, et al.[15] conducted a survey on 1,085 leg amputees who reported to the Counsel Service for Rehabilitation of the Handicapped in Okayama Prefecture to receive artificial legs over a 5-year period between 1969 and 1973. They reported that 9.2% underwent amputation as a consequence of peripheral circulatory dysfunctions (mostly Buerger's disease). Ando, et al.[16] studied the causes for leg amputation of those who reported to receive certificates for the handicapped between 1968 and 1972. They stated that 26.3% of the patients undergoing leg amputation due to ischemic diseases were over 50 years of age. According to the 1979 report by the Japanese Society of Rehabilitation Medicine, the causes for amputation were general accidents (33%), illnesses (30%), industrial accidents (21%), and war injuries (15%). Tumors were a dominant cause for amputation but ischemic conditions led to amputation in 8.5% and 2.5% for men and women, respectively. Nagashima, et al.[17] focused on recently amputated patients in Okayama Prefecture between 1979 and 1980. According to their records for the physically disabled, amputation was performed because of ischemic diseases in 51.1%, traumatic causes in 26.4%, and tumors in 15.5%, indicating that ischemic conditions were the most prevalent cause for amputation. Nakagawa, et al.[13] in their 1985-1988 report on surgical amputation, stated that circulatory dysfunctions accounted for 60%, traumatic causes, 24%, and tumors, 14%. These reports indicate that before 1980, traumatic causes, such as those related to traffic and occupational accidents, dominated as the causes for amputation. This trend reached a peak around 1965, after which causes such as peripheral circulatory disorders and tumors replaced the traumatic causes. According to recent reports from Europe and the United States,[18] peripheral ischemia due to arteriosclerosis or diabetes mellitus account for more than 60% of the causes for leg amputation; and the patients' ages are mostly 60 years or more. Thus one might conclude that the causes for leg amputation in this country is being westernized. In this study, the subjects were leg amputees who had their initial amputation between 1930 and 1997; and in which trauma accounted for 61.1%; ischemic conditions, 14.4%; and tumors, 8.3%, showing that trauma was the outstanding cause of amputation. In the more recent 10 years, i.e., in the 1990s, diabetes mellitus (31,2%), traffic accidents (16.6%), tumors (12.5%), and other unspecified illnesess (10.2%) have been blamed. Diabetes mellitus was the most dominant cause and, like other reports, traumatic causes were cited less frequently, while amputation was necessitated more often by ischemic conditions (mostly diabetes mellitus). The results of the study by Nakagawa, et al.[13] and those presented by the Japanese Society of Rehabilitation Medicine,[11] together with the conclusion of our survey point to a change that is taking place in Japan in recent years, as it is in the western, where leg amputation in the aged due to ischemic causes (mainly due to diabetes mellitus) is on the rise, replacing the traumatic causes that accounted for amputation in the younger age groups.

Amputation due to traumatic causes frequently occurs at a relatively younger age, while diabetes develops more frequently among the aged. For the causes for amputation and the time that elapses between amputation and the present, this survey showed that the time between amputation due to traffic accidents and work-related injuries and the present is significantly longer than that caused by disease conditions, such as diabetes mellitus.

This study showed that below the knee amputation was the most common type of amputation, followed by thigh transection, foot amputation, and hip or knee disarticulation, a pattern that roughly coincided with the reports by the Japanese Society of Rehabilitation Medicine.[11] There is about a 20-year time gap between the present study and when the latter was presented: yet no marked difference was noted between the two. Statistics on bilateral leg amputation vary considerably by region, reports the same Japanese Society of Rehabilitation Medicine reports (29.5% in Tokyo, 11.0% in Okayama, and 10.0% in Hyogo). This study was conducted on leg amputees residing in Osaka Prefecture, where the bilateral leg amputation was 6.9%, which was lower than for the neighboring prefectures of Hyogo and Okayama.

The relationship between the causes for amputation and the anatomical sites of leg amputation is not included in the reports by the Japanese Society of Rehabilitation Medicine.[11] Ebskov conducted a statistical analysis on 25,767 Danish leg amputees between 1978 and 1989 and reported that amputation due to vascular diseases (such as arteriosclerosis) takes place more frequently above or below the knee (more

frequently below); and in cases of diabetes mellitus, below knee amputation is overwhelmingly more common. In the same report, Ebskov reported that for tumor patients, hip resection or thigh amputation was the common mode of amputation, while for trauma, the site of amputation was equally divided between below and above the knee. The results of our study generally corresponded to the results presented by Ebskov.[10]

The present study was conducted to find the causes leading to amputation, which, it was suspected, revolved around changes in the societal structure and morbidity patterns. A marked increase in the incidence of leg amputation due to diabetes mellitus was found. This disease ranks 10th (1998) in a list of the causes of death: it not only constitutes a risk factor for diseases with high mortality (e.g., cerebrovascular disorders and myocardial infarction) but is also responsible for other serious complications. In 1996, 9,500 patients with diabetic nephropathy were newly introduced to hemodialysis, with a steady increase each year. Furthermore, about 3,000 patients with diabetic retinopathy are judged to be visually handicapped each year. Diabetes mellitus is not only responsible for these complications but serves as the major cause for leg amputation, which is a formidable detriment to coping with the activities of daily living.

The results of the present study clearly indicated that the prevention of diabetes mellitus is an important objective for improving the QOL and prolonging a healthy life for the aged.[19]

The outstanding features and limitations of this study have been shown. For the age at amputation, past studies and the report by the Japanese Society of Rehabilitation Medicine indicated the age distribution of the amputees during a certain period. In the present study, the distribution of the age at amputation was computed for each age group. It is believed that this is very important for evaluating annual changes in the cause for amputation and other pertinent matters. However this is a retrospective cohort study that did not include deceased amputees. Thus in examining the age at and cause for amputation, the age distribution at amputation for each age group is estimated from the data on amputees who are still alive. A certain bias is inevitable and it is clear that the percentage of younger amputees increases when the older data are used. In fact, the present study was conducted on leg amputees who were alive in April 1998. Judging by the age of the respondents and their mean life expectancy, the percentage of the aged increased for each succeeding generation.

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