[Environmental Health and Preventive Medicine 12, 246–250, November 2007]

Original Article

Association of Thoracic Kyphosis with Subjective Poor Health, Functional Activity and Blood Pressure in the Community-Dwelling Elderly

Yuji NISHIWAKI[1], Yuriko KIKUCHI[1], Kazufumi ARAYA[2], Michiko OKAMOTO[3], Shingo MIYAGUCHI[4], Noriyuki YOSHIOKA[1], Naoki SHIMADA[1], Hiroshi NAKASHIMA[1], Takamoto UEMURA[5], Kazuyuki OMAE[1] and Toru TAKEBAYASHI[1]

[1]*Department of Preventive Medicine and Public Health, School of Medicine, Keio University, Tokyo, Japan*
[2]*Harunaso Hospital, Gunma, Japan*
[3]*Health and Welfare Division, Kurabuchi Branch Office, Takasaki City Hall, Gunma, Japan*
[4]*Usui Hospital, Gunma, Japan*
[5]*Department of Public Health, School of Medicine, Kyorin University, Tokyo, Japan*

Abstract

Objectives: The prevalence of thoracic kyphosis is considered to increase as the population is ageing in Japan. However, little is known about the clinical and preventive significance of kyphosis. The purpose of the study is to assess the association of kyphosis with subjective poor health and functional activity in the community-dwelling Japanese elderly. The relation of kyphosis with blood pressure, as a subclinical indicator of arteriosclerosis, is also examined.

Methods: The subjects consisted of 536 (male 241, female 295) elderly persons aged 65 years old and older. Trained examiners measured thoracic kyphosis using a flexicurve, and kyphosis index was calculated. Information on the subjects' subjective poor health and functional activity were collected through a face-to-face interview, and blood pressure was measured by a conventional method.

Results: In females, their kyphosis index increased with age increased, whereas in males, there was no clear age-related change. An increased kyphosis index was associated with subjective poor health only among females. Compared with the lowest kyphosis index tertile, adjusted odds ratios for being in poor health were 5.4 (95% confidence interval: 1.1–27.4) in the middle tertile, and 6.4 (95% confidence interval: 1.3–32.1) in the highest tertile. Kyphosis index did not seem to be associated with functional activity score and blood pressure both in males and females even after adjustment.

Conclusions: Kyphosis is associated with subjective poor health in the community-dwelling female elderly in this study population, but not with functional activity and blood pressure both in males and females.

Key words: kyphosis, aged, community, frailty

Introduction

Although many studies of standing posture have been carried out (1), little is known about the clinical and preventive significance of thoracic kyphosis. As population is ageing, the prevalence of kyphosis is considered to increase. Most of the previous studies of kyphosis were carried out in clinical settings (2, 3), however, information on basic epidemiological measures such as the incidence and prevalence of kyphosis in a community is lacking.

Kyphosis was reported to be associated with ventilatory dysfunction (4), diminished daily physical function (5), impaired quality of life (6), and increased mortality (7, 8). These reports suggest that kyphosis can be one of the comprehensive indicators of ageing and frailty of the elderly. If so, as simple external physical measurements are available, examining kyphosis would be useful for identifying frail elderly persons in a community from the public health perspective. However, there are few studies on the relationship of kyphosis with health-related outcomes such as subjective health and functional activity in Japan (6, 9). Whereas a recent study in the U.S.

Received Mar. 31, 2007/Accepted Jul. 23, 2007
Reprint requests to: Yuji NISHIWAKI
Department of Preventive Medicine and Public Health, School of Medicine, Keio University, Shinanomachi 35, Shinjyuku-ku, Tokyo 160-8582, Japan
TEL: +81(03)3353-1211 (ext 62655), FAX: +81(3)3359-3686
E-mail: nisiwaki@sc.itc.keio.ac.jp

showed the relationship of hyperkyphotic posture with arteriosclerosis (10), no such study has been carried out in Japan so far.

Therefore, the purpose of the study is to assess the association of kyphosis with subjective poor health and functional activity in the community-dwelling Japanese elderly, because these health-related outcomes were reported to be very good predictors of frailty (11–13). We also examined the relationship of kyphosis with blood pressure, as a subclinical indicator of arteriosclerosis.

Materials and Methods

This cross-sectional study was conducted during the annual medical checkup of residents of Kurabuchi town (currently Takasaki City) in September, 2004. This local mountain town, whose population was approximately 4800 in 2004, is located in central area of Japan and 25% of the residents are engaged in agriculture and forestry.

Of the 1534 eligible residents aged 65 years old and older, 587 (38%) participated in this medical checkup. Among them, 536 (91%: male 241, female 295) gave their written informed consent to participate in the study and were thus included. The median age (interquartile range) for the subjects was 72.4 (68.7–77.6) years old. The study was approved by the Ethical Committee of the School of Medicine, Keio University.

Measurement of kyphosis

Trained examiners measured thoracic kyphosis by the method of Milne and Lauder (14). A flexicurve was pressed against the subjects' back so that the upper end of the flexicurve was set at the C7 spinous process and the lower end was placed at the lumbosacral joint level. We instructed the subjects to stand relaxed and naturally during the measurement. The outline of the flexicurve was then placed on a piece of paper and the curve traced by running a pen along the flexicurve. The index of thoracic curvature, the kyphosis index, was calculated according to the equation shown in Fig. 1.

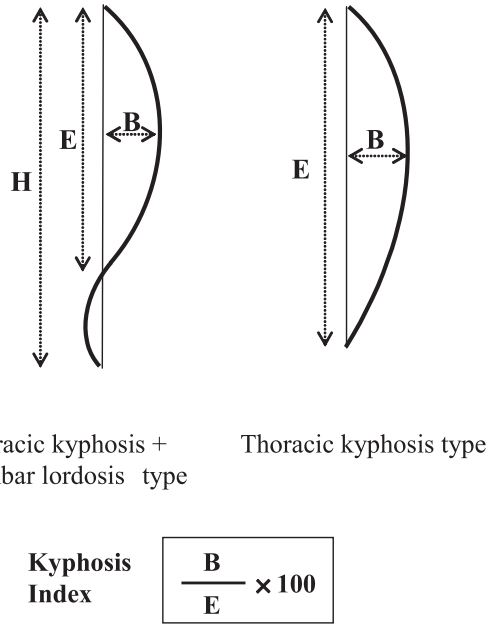

Fig. 1 Calculation of kyphosis index by Milne and Lauder.

Subjective poor health, functional activity and blood pressure

Information on the subjects' subjective poor health and functional activity were collected through a face-to-face interview by trained interviewers on the same day of the kyphosis measurement. The subjects who responded "poor" or "very poor" to the question about their subjective health status (five-grade evaluation) were considered to be in poor health.

The functional activity of the elderly was examined using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) (15, 16). This 13-item index was designed to assess instrumental self-maintenance, intellectual activity, and social role. The final possible scores ranged between 0 (the worst) and 13 (the best). The subjects were classified into the group with "declined functional activity" when the score was 11 (the lowest quartile in this population) or lower, changing the cut-off score to 10 or 12 did not alter the results.

Blood pressure was measured using an automatic sphygmomanometer (Colin BP-103i) after a 15 minute rest. Measurement was repeated twice with an at least 30-second interval and the second record was adopted for a subject's representative value. The presence of hypertension was determined by asking the subjects whether they had ever been told of having hypertension by their physicians.

Covariates

Other data including age, smoking status, alcohol drinking, and past/current history of diseases such as stroke, myocardial infarction, angina, cancer and diabetes mellitus was collected in the same face-to-face interview. Body mass index (BMI) and total cholesterol level in serum, which were examined in the routine medical checkup, were also used as covarites for the current study.

Statistical analysis

The distribution of kyphosis index is shown by sex and age categories (65–69, 70–79, 80– years old). Prevalences of subjective poor health, declined functional activity, and hypertension, median functional activity score and mean blood pressure were compared across sex- and age category-specific tertiles of kyphosis index. Statistical tests used in the study were analysis of variance (ANOVA), Kruskal-Wallis test, Fisher's exact method and the trend test by Cuzick and Altman (17). Variables included in the multiple regression and logistic models were age, smoking status, and past/current history of life threatening diseases such as stroke, myocardial infarction, angina, cancer, and diabetes mellitus. BMI and total cholesterol level were also included in the models for blood pressure and hypertension. Drinking habit was not included as we did not construct a valid model, however, alcohol drinking did not confound the observed association. All statistical analyses were performed using Stata 9 software (Stata Corporation, College Station, Texas).

Results

In females, the kyphosis index increased with age, whereas in males, there was no statistically significant age-related change although a higher kyphosis index was observed in the highest age category than in other age categories (Table 1).

Table 2 shows the association of kyphosis with subjective poor health, functional activity and blood pressure in terms of age and sex categories. Although we did not carry out statistical tests at this stage to avoid multiple comparison, an increased kyphosis index seemed to be associated with the subjective poor health among females, but not among males. By contrast, there were no clear trends for functional activity and blood pressure.

Compared with the lowest kyphosis index tertile, adjusted odds ratios for being in poor health were 5.4 (95% confidence interval: 1.1–27.4) in the middle tertile, and 6.4 (95% confidence interval: 1.3–32.1) in the highest tertile for females (Table 3).

Kyphosis did not seem to be associated with the prevalence of declined functional activity and hypertension both in males and females even after adjustment (Table 3). When we used systolic blood pressure as a dependent variable, multivariate adjusted differences (95% confidence interval) for the middle and the highest tertiles compared with the lowest tertile were −1.9 (−7.3–3.5) and −4.6 (−9.9–0.9) for females and −2.4 (−9.1–4.3) and −3.7 (−10.4–2.9) for males, respectively. Corresponding diastolic blood pressures were −0.4 (−3.4–2.7) and −0.6 (−3.7–2.4) for females and −1.6 (−5.3–2.1) and −3.1 (−6.8–0.7) for males, respectively. These results were not substantially affected by the exclusion of subjects with hypertension.

Discussion

In clinical settings the golden standard for the measurement of kyphosis may be radiographic examination. However, this method is impractical in local community settings. In contrast, measurements of kypshosis index, occiput to table distance (10), and occiput to wall distance (5) are brief,

Table 1 Kyphosis index by sex and age categories

	Female (n=295)			Male (n=241)		
	n	Median	Interquartile range	n	Median	Interquartile range
Age category						
65–69 y.o.	96	7.8	6.0–10.8	87	9.1	7.7–10.6
70–79 y.o.	141	9.5	6.8–12.8	125	9.0	7.1–10.8
80– y.o.	58	11.0*	8.6–15.1	29	10.7	8.1–12.6

*: P value for the trend test by age category <0.01.

Table 2 Association of kyphosis with subjective poor health, functional activity and blood pressure

Sex and Age Categories	Kyphosis Index Tertile*	Number	Kyphosis Index	Age (y.o.)	Subjective Poor Health	Functional Activity#		Blood Pressure		
			Median	Mean±SD	No. (%)	Median Score (interquartile range)	Score 11 or below No. (%)	SBP$ (mmHg) Mean±SD	DBP$ (mmHg) Mean±SD	Hypertension No. (%)
Female										
65–69 y.o.	Low	32	5.3	67.6±1.5	0 (0.0)	13 (13–13)	5 (16.7)	138.8±18.5	78.9±11.4	11 (34.4)
	Middle	32	7.8	67.2±1.8	0 (0.0)	13 (12–13)	6 (23.1)	132.7±20.4	77.2±11.3	7 (21.9)
	High	32	12.5	67.3±1.5	1 (3.1)	13 (12–13)	3 (10.7)	134.2±21.7	78.8±12.7	13 (40.6)
70–79 y.o.	Low	45	5.6	73.7±3	1 (2.2)	12 (11–13)	11 (27.5)	140.2±18.3	78.4±9.8	15 (33.3)
	Middle	47	9.1	74.1±2.9	7 (14.9)	12 (11–13)	15 (34.1)	138.6±16.8	78.5±10.5	25 (53.2)
	High	49	14.5	75.4±2.9	6 (12.5)	12 (11–13)	19 (41.3)	131.5±18.3	75.6±10.1	20 (40.8)
80– y.o.	Low	19	7.4	83.8±3.8	1 (5.3)	11 (7.5–11.5)	12 (75.0)	136.8±14.3	74.3±7.5	5 (26.3)
	Middle	18	10.9	82.7±2.4	2 (11.1)	10.5 (8.5–12)	9 (56.3)	143.6±25.5	77.7±13.2	5 (27.8)
	High	21	16.6	83.9±3.5	4 (19.1)	10 (8–12)	12 (57.1)	147.4±26.5	80.7±11.1	7 (33.3)
Male										
65–69 y.o.	Low	27	7.0	67.6±1.4	1 (3.9)	13 (12–13)	6 (23.1)	141.9±23.1	86.0±13.9	11 (40.7)
	Middle	31	8.9	67.6±1.6	0 (0.0)	13 (12–13)	6 (20.0)	139.2±19.6	84.0±11.9	6 (19.4)
	High	29	11.2	67.2±1.6	3 (10.3)	12 (11–13)	8 (27.6)	142.2±17.0	84.2±10.6	13 (46.4)
70–79 y.o.	Low	38	6.4	74.1±2.8	3 (7.9)	13 (12–13)	7 (21.9)	142.9±22.6	81.7±14.3	17 (44.7)
	Middle	45	8.8	74.4±2.7	1 (2.3)	13 (11–13)	12 (27.3)	140±20.4	79.5±11.3	23 (51.1)
	High	42	12.2	73.7±2.5	3 (7.3)	12 (11–13)	15 (36.6)	132.3±23.0	75.1±9.4	13 (31.7)
80– y.o.	Low	9	3.6	83.9±2.8	1 (11.1)	12.5 (11.5–13)	2 (25.0)	133.6±18.7	74.4±13.5	2 (22.2)
	Middle	9	10.5	84.0±5.0	1 (11.1)	11 (9–13)	5 (55.6)	133.7±18.1	73.1±8.9	4 (44.4)
	High	11	12.7	84.9±4.3	1 (9.1)	12 (11–12)	5 (45.5)	136.9±18.8	77.1±12.2	3 (27.3)

*: Age category- and sex-specific tertile.
#: Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) was used.
$: SBP, systolic blood pressure; DBP, diastolic blood pressure.

noninvasive methods of external assessment of kyphosis. These are suitable for busy local settings and can easily be carried out by examiners without requiring special knowledge and equipment. In particular, kyphosis index has good interrater and intrarater reliability (3). One drawback of this kyphosis index is that it does not measure spinal alignment including the cervical spine.

Although evidence for the notion that kyphosis predicts future frailty including death in the elderly is now accumulating in developed countries (7, 10), few studies of kyphosis have been carried out in Japan. The results of our present study revealed that kyphosis is associated with subjective poor health in females but not in males. Decreased quality of life (6) and low life satisfaction level (9) due to trunk deformity including kyphosis have been reported in Japan, although trunk deformity was evaluated on the basis of radiographs and photographs. An enhanced subjective poor health observed in the subjects with a high kyphosis index seemed consistent with these studies. However, the mechanism explaining this relationship is unknown. Because the relationship was not attenuated by adjusting functional activity score, it is not likely to be explained by a subject's declined functional activity. Subjects with a high kyphosis index might feel undesirable and disabled in terms of appearance. These feelings may lead to an enhanced subjective poor health. Further studies including an assessment of subjects' depressive mood will be warranted.

The association between kyphosis and subjective poor health was not observed in males. The discrepancy between genders may be due to a difference in vulnerability to their appearance. Another explanation for gender discrepancy might be the observation that kyphotic change was more common in females than in males in this study population. Indeed, the upper 25 percentile of kyphosis index for each age category was higher in females than that in males, although median values were not markedly different (Table 1). In the report by Milne and Lauder, who developed the kyphosis index, females seemed to have higher kyphosis index (14).

Milne and Lauder also noted the change in kyphosis index with age and that females showed a steeper increase with ageing than males for subjects above 65 years old (14). Our study result was in agreement with the report by Milne and Lauder. However, it should be noted that the number of male subjects aged 80 years old and older was small in our current study.

Table 3 Crude and adjusted odds ratio for subjective poor health, declined functional activity and hypertension

	Kyphosis Index Tertile*	Number (%)	Crude OR#	95% CI$	Age-adjusted OR	95% CI	Multivariable-adjusted OR&	95% CI
Subjective poor health								
	Female							
	Low (n=96)	2 (2.1)	1.0	—	1.0	—	1.0	—
	Middle (n=96)	9 (9.4)	4.9	1.0–23.1	5.0	1.1–24.1	5.4	1.1–27.4
	High (n=101)	11 (10.9)	5.7	1.2–26.6	5.5	1.2–25.6	6.4	1.3–32.1
	Male							
	Low (n=73)	5 (6.9)	1.0	—	1.0	—	1.0	—
	Middle (n=84)	2 (2.4)	0.3	0.1–1.8	0.3	0.1–1.8	0.3	0.1–1.8
	High (n=81)	7 (8.6)	1.3	0.4–4.2	1.3	0.4–4.3	1.3	0.4–4.6
Declined functional activity¥								
	Female							
	Low (n=86)	28 (32.6)	1.0	—	1.0	—	1.0	—
	Middle (n=86)	30 (34.9)	1.1	0.6–2.1	1.1	0.6–2.2	1.0	0.5–2.0
	High (n=95)	34 (35.8)	1.2	0.6–2.1	1.0	0.5–1.9	1.0	0.5–1.9
	Male							
	Low (n=66)	15 (22.7)	1.0	—	1.0	—	1.0	—
	Middle (n=83)	23 (27.7)	1.3	0.6–2.8	1.3	0.6–2.7	1.2	0.5–2.6
	High (n=81)	28 (34.6)	1.8	0.9–3.7	1.8	0.8–3.7	1.6	0.7–3.5
Hypertension								
	Female							
	Low (n=96)	31 (32.3)	1.0	—	1.0	—	1.0	—
	Middle (n=97)	37 (38.1)	1.3	0.7–2.3	1.3	0.7–2.3	1.2	0.6–2.2
	High (n=102)	40 (39.2)	1.4	0.8–2.4	1.3	0.7–2.4	1.3	0.7–2.3
	Male							
	Low (n=74)	30 (40.5)	1.0	—	1.0	—	1.0	—
	Middle (n=85)	33 (38.8)	0.9	0.5–1.8	0.9	0.5–1.8	0.8	0.4–1.7
	High (n=80)	29 (36.3)	0.8	0.4–1.6	0.8	0.4–1.6	0.8	0.4–1.6

*: Age category- and sex-specific tertile. Number does not add up to 295 for females and 241 for males due to missings.
#: OR, odds ratio.
$: CI, confidence interval.
&: Age, smoking status (current/ex/none) and history of diseases were adjusted for. BMI and total cholesterol level were also included in the models for hypertension.
¥: Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) score of 11 or below.

This survey was conducted at the time of residents' routine medical checkup run by the town according to the Health and Medical Service Law for the Aged. The participation proportion in this medical checkup in 2004 was low (38%). It is known that healthier residents are more likely to participate in health checkup. Thus, the absence of association between kyphosis and declined functional activity might be explained by the low participation proportion of those with impaired functional activity. Indeed, the functional activity score of the study subjects was generally high and score variation was narrow; the 25 percentile, median and 75 percentile of the TMIG-IC score were 11, 12 and 13, respectively.

As not only mean blood pressure but also the prevalence of hypertension were not related to kyphosis index, kyphosis might not be a good marker of arteriosclerotic change.

As limitations of the study, a possible bias should be discussed. Although blinding was not possible because the interviewers were able to see the subjects' posture, all interviewers participated the training session, used the same questions and more importantly had no particular knowledge on the association between kyphosis and subjective health. Therefore, information bias was less likely. Selection bias was also less likely, unless the kyphotic elderly with subjective good health or the nonkyphotic elderly with subjective poor health had been selectively excluded from this study, although this bias could not be eliminated comletely. As mentioned above, however, population representativeness of the study subjects was low because of the low participation proportion in this survey. We were not able to collect information on the subjects' socioeconomic status such as education owing to privacy reasons in this survey. Therefore, confounding by the socioeconomic status can not be denied. It should also be noted that 95% confidence intervals for the odds ratios were quite wide, reflecting a relatively small number of subjects with subjective poor health. A study of a larger population is necessary.

In conclusion, kyphosis is associated with subjective poor health in the community-dwelling female elderly in this study population. As subjective health is a strong predictor of mortality (18), a simple external evaluation of kyphosis in the elderly may have a value as a method of measuring frailty in a community setting. Kyphosis is not related to functional activity and blood pressure both in males and females.

Acknowledgments

The authors would like to thank the staff members of the Health and Welfare Division of Kurabuchi Branch Office of Takasaki City Hall and Harunaso Hospital. The authors report no conflicts of interest either related to the research or to the manuscript.

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