M-2282(R)

Mid-arm and calf circumferences (MAC and CC) are better than body mass index (BMI) in predicting health status and mortality risk in institutionalized elderly Taiwanese

Alan Chung-Hong Tsai[a,b,*], Ming-Chen Lai[a,c], Tsui-Lan Chang[a,d]

[a]Department of Healthcare Administration, Asia University, 500 Liufeng Rd., Wufeng, Taichung 41354, Taiwan

[b]Department of Health Services Management, China Medical University, 91 Hsueh-Shih Road, Taichung 40402, Taiwan

[c]Puli Veterans Hospital, Puli, Nantou 54552, Taiwan

[d]Nursing Department, Hsin Yung Ho Hospital, Taoyuan 32441, Taiwan

[*]Corresponding author
Phone: +(886-4)-2332-3456, ext.1943
Fax: +(886-4)-2332-1206
E-mail: atsai@umich.edu

Abstract

The study was to compare the ability of BMI, MAC and CC in predicting nutritional status, functional ability and follow-up mortality risk of older adults. The study purposively recruited 160 of 320 residents of a nursing home in Central Taiwan to serve as subjects. Residents who were ≥ 65 years old, cognitively normal, without acute conditions and non-hospitalized were qualified to participate. All subjects signed an informed consent. Each was interviewed with a structured questionnaire for sociodemographic, lifestyle and health-related information; evaluated with the Mini Nutritional Assessment (MNA) and the Activities of Daily Living (ADL) scales; measured for weight, height, MAC and CC; and assayed for nutrition-related biochemical values. Results showed that CC was the best, followed by MAC and then BMI in predicting the nutritional status and health conditions. CC and MAC were also more effective than BMI in predicting 12-month follow-up mortality. Overall, CC is the most capable in predicting nutritional status, functional activity and general health conditions; MAC is the most capable in predicting 12-month follow-up mortality risk whereas BMI is the weakest in all functions. These results should have practical implication in geriatric health measurements.

Keywords: body mass index, mid-arm circumference; calf circumference; functional status of elderly

1. Introduction

Anthropometry is an essential tool in geriatric assessment for evaluating malnutrition, functional decline and chronic health conditions which are important risk factors of geriatric frailty, disability and mortality (Seidell and Visscher, 2000) Simple anthropometric indices such as the BMI, weight change and circumferences of extremities especially upper MAC and CC are often included in geriatric assessment tools (Green and Watson, 2006; Donini et al., 2007).

All these indices are influenced to some degree by energy balance, and each has specific health implications. BMI is an index of weight relative to height (kg/m^2) and reflects mainly energy balance. MAC and CC reflect subcutaneous fat and body muscle mass and are influenced by both energy balance and local muscle activity such as arm movement and walking activity. MAC and CC can decrease in size during functional decline or long-term inactivity even with adequate nutritional intake. BMI can

be maintained or increased by maintaining or increasing energy intake even during functional decline or long-term inactivity. During undernutrition, frailty or geriatric wasting, CC is a better indicator of body muscle mass because the legs contain over half of the muscle mass of the body and it is more directly impacted by reduced walking which is among the first things to happen during illness (Chumlea, 2006); MAC reflects subcutaneous fat well but body muscle mass poorly because movement of the arms in daily activities occurs until the very late stage of wasting, which helps maintain muscle mass locally (Chumlea, 2006). Overall, BMI is a good indicator of weight change; CC is a good indicator of functional status; and MAC is a good indicator of terminal functional decline.

These simple anthropometrics have been included in nutritional assessment and screening scales and many of these scales have been shown to have the ability to predict functional decline, morbidity and follow-up mortality risk (Shibata et al., 1992; Bonnefoy et al., 2002; Deschamps et al., 2002; Donini et al., 2003; Powell-Tuck and Hennessy, 2003; Zhu et al., 2003; Allard et al., 2004; Reid et al., 2008). The association of these anthropometric indices, especially BMI and to a lower degree MAC, with lifestyle-related chronic diseases has been the subject of intensive investigation in recent years (Wannamethee et al., 2004; Lin et al., 2006). However, relatively few studies have ever examined the usefulness of BMI, MAC and CC in predicting health status, frailty, functional ability or mortality in older adults simultaneously. The present study was aimed to do such in a group of elderly Taiwanese nursing home residents.

2. Subjects and methods

2.1. Design and subjects

The study employed convenience sampling and recruited residents of a Veterans' Administration Hospital-managed nursing home in Central Taiwan as study subjects. Since veterans were predominantly male, this study involved only male subjects. Residents who were ≥ 65 years old, residents of the center for ≥ 30 days, and non-hospitalized, without acute infection and cognitively able to communicate verbally were recruited to participate. Among 320 total residents, 160 met those conditions and agreed to participate in the study. The major reasons for non-participation were cognitive impairment, being unconscious, hospitalization or refused to participate. The Institutional Review Board of the hospital approved the study protocol. Written consent

was obtained from each participant or the legal guardian. Subjects' confidentiality was maintained throughout the study.

2.2. Measurements

The study included three components: (a) an on-site in-person interview with a structured questionnaire for eliciting sociodemographic, lifestyle and health-related personal data, and answers to items in the MNA (Tsai and Ku, 2008) and the ADL scales (Inouye et al., 1993); (b) measurements of anthropometric indicators including body weight, height, MAC and CC according to standard methods (Lee and Nieman, 2003), and (c) measurements of fasting blood biochemical indicators including serum albumin, hemoglobin, glucose, triglyceride, and total cholesterol as a part of hospital's routine laboratory tests. During the interview, the caregivers were allowed to assist subjects answering the questions if necessary. Anthropometric measurements and the questionnaire interview were carried out within one week of the blood sampling date. The nutritional status of each subject was rated with the original MNA but normalized to account for population-related anthropometric differences by adopting Taiwanese-specific anthropometric cut-off points (Tsai et al., 2010). All interviews and physical measurements were carried out by the same (one) interviewer (LMJ).

2.3. Statistical analysis

Data and results were analyzed with SPSS/Windows 12.0 software package (Statistical Package for the Social Sciences, Chicago, IL). Simple statistics were expressed as mean ± S.D. Spearman's correlation was applied to determine the strength of correlation of each of the anthropometric parameters (BMI, MAC and CC) with the major nutrition/health status indicators. Cox regression was performed to determine the relative mortality risk of subjects stratified by BMI, MAC and CC statuses adjusted for age. Statistical significance for all analyses was evaluated at $\alpha = 0.05$.

3. Results

Table 1 shows the basic characteristics of subjects. The average age was 81.1 years. Seventy percent of subjects were 75-84 years old; 18% were current smokers and 25.5% were past smokers; and 5.6% drank alcohol once or more per week. The average BMI was 21.5 kg/m^2; MAC was 24.8 cm; and CC was 28.3 cm. The average hemoglobin was 12.5 g/dl and 34.4% of subjects had subnormal levels (< 14 g/dl); the

average serum albumin was 3.6 g/dl and 35.6% had low levels (< 3.5 g/dl); the average cholesterol concentration was 147.6 mg/dl and over half (54.4%) were below the 150 mg/dl; the average fasting blood glucose was 94.1 mg/dl and 33% were over the 100 mg/dl. Nearly 50% of subjects had two or three lifestyle-related chronic diseases; 40.6% were taking 1-3 kinds of prescribed medicine and the same proportion were taking four or more kinds; 45% of subjects had hospitalization for one or more days during the past 6 months. Nearly half (45.6%) were totally dependent, 17.5% were severely dependent, 18.1% were moderately dependent and the rest (18.8%) were mildly dependent according to ADL dependency scale.

The mean BMI, MAC and CC values were lower in elderly classified malnourished or at risk of malnutrition compared to those rated normal and clearer differences were seen in MAC and CC compared to BMI (Table 2). Greater proportions of elderly rated at risk of malnutrition or malnourished had BMI, MAC and CC below the respective cut-off point values and clearer differences were seen in MAC and CC than in BMI.

Table 3 shows the strength of relationship between BMI, MAC and CC with each of the major nutrition/health indicators. MAC and CC were significantly correlated with all six indicators whereas BMI was significantly correlated with only four indicators and the strength of each relationship was stronger with MAC and CC than with BMI.

Figure 1 shows the age-adjusted 12-month follow-up survival curves stratified by BMI, MAC and CC statuses, respectively. The 12-month survival rates for those who had low BMI (< 21 kg/m^2) were not different from those had higher BMI. But, those who had low MAC (< 22.5 cm) or CC (< 28 cm) had significantly greater mortality risk during the period.

4. Discussion

4.1. Predicting morality risk

Results of the present study suggest that MAC and CC but not BMI predict follow-up mortality risk in this group of institutionalized elderly men. When stratified by MAC or CC cut-off points, elderly who have low MAC (< 22.5 cm) or CC (< 28 cm) have significantly increased mortality risk during the follow-up 12-month period compared to those who have normal MAC or CC. When stratified by BMI cut-off point (< 21 kg/m^2), the resulting difference in mortality risk was not significant. Between MAC and CC, MAC can predict mortality risk better than CC. Previous studies have shown that MAC

can predict mortality risk in community-dwelling frail elderly in a 2-year longitudinal study (Enoki et al., 2007) and in nursing home residents (Tajima et al., 2004); and in long-term care residents. Elderly with MAC < 26 cm had 4.8 times of the mortality risk of those having MAC > 26 cm (Allard et al., 2004).

Low BMI has been observed to be a predictor of all-cause mortality in some (Landi et al., 1999; Flodin et al., 2000; Seidell and Visscher, 2000; Enoki et al., 2007) but not all studies and the strength of relationship between BMI and mortality is generally weaker than that with MAC. Mazza et al. (2007) observed a significant relationship only in men aged 76 years or less and no relationship was observed in women. Woo et al. (2001) observed that weight loss, low BMI and MAC were associated with increased mortality in Chinese ≥ 70 years of age in Hong Kong. On the other hand, Volpato et al. (2004) did not find an association of BMI with the risk of death after multivariate adjustment in a 4-year study in older nursing home residents. Over all, the association of mortality risk with BMI in older adults appears weaker than with MAC.

Compared to BMI and MAC, fewer studies have examined the mortality-predictive ability of CC. Mason et al. (2008) examined the influence of central and extremity circumferences on all-cause mortality in a 12-year prospective study involving 10,638 Canadian men and women aged 20-69-years. Waist and extremity circumferences were observed to have independent but opposite effects on mortality. Men and women with larger extremity circumferences (such as MAC and CC) had a lower risk of mortality independent of BMI and waist circumference.

4.2. Predicting health and nutritional statuses

Results of the present study show that BMI not only is less effective in predicting mortality risk, it is also less correlated with general health statuses compared to MAC and CC in nursing home residents. While all three anthropometric parameters are significantly correlated with general nutritional indicators such as hemoglobin and serum albumin, and with general functional status (ADL score), the strength of relationship with BMI is less compared to that with MAC or CC. Further, only MAC and CC, not BMI, are significantly correlated with general health indicators such as number of chronic diseases, hospital length of stay and number of emergency visit. Taken together, among the three indicators examined, MAC is the most effective in predicting follow-up mortality risk and CC is the most effective in reflecting current general health

and nutrition statuses. BMI is the least effective in predicting all these parameters in this group of institutionalized elderly men.

Our observations are in line with some earlier findings. Bonnefoy et al. (2002) examined the usefulness of CC for assessing the nutritional status of hospitalized elderly patients and suggested that CC is a pertinent parameter. CC showed stronger correlations with serum albumin and BMI against other anthropometric indices. On the other hand, Burden et al. (2005) found that low MAC had a high specificity but low sensitivity when compared with indicators of malnutrition and the percentiles based on healthy populations do not generalize well with that seen in clinical practice. Luchsinger et al. (2003) also found that BMI was not a good predictor of hospitalization for most individuals aged 75 years or older after analyzing 18,754 non-institutionalized 65-100 years old elderly at baseline.

In the current study, BMI status does not reflect well the functional decline. A possible explanation is that nearly one-quarter of the residents were tube-fed which maintained or increased body weight and BMI. Many residents have large trunk due to accumulation of abdominal fat but with small extremities. During geriatric functional decline, losing the ability to walk generally precedes losing arm moving ability and the movement of the arm helps to maintain muscle locally (Chumlea, 2006). Elderly on tube-feeding generally are functionally impaired and have severely reduced extremities. Thus, CC is a stronger indicator of functional decline because it reflects muscle-related disability and physical functioning (Rolland et al., 2003) whereas MAC is a better indicator of mortality risk because it reflects terminal functional decline (Lunney et al., 2003).

Taken together, CC seems to be a reliable indicator of nutritional or functional status whereas MAC appears to be a usefulness predictor of mortality risk. These two indicators are particularly relevant to clinical practice because both are readily accessible and relatively easy to measure (compare to weight and height measurements), particularly for frail or hospitalized patients who require regular monitoring. Monitoring of these indicators may help improve the care of geriatric patients in long-term care institutions (Coelho et al., 2006).

Anthropometric indices are relatively universally applicable, inexpensive, non-invasive and usually simple and easy to measure. However, the use of anthropometric indicators in elderly populations is relatively limited, perhaps due to the lack of reference standards. The usefulness of anthropometry as an indicator of

nutritional status is dependent on the availability of age-, gender- and ethnicity-specific data and it has been suggested that local anthropometric data should be collected in healthy older age groups (WHO, 1995).

4.3. Limitations of the study

This study has some obvious limitations. The nature of the institution limits the study to involve only male subjects. The applicability of the study results to female elderly remain to be examined. Geriatric care and nutritional care vary greatly among institutions. The quality of care can impact body weight, functional ability and survival greatly. Other anthropometric indices such as waist circumference, lean body mass or hip/waist ratio would probably be meaningful to be included in future studies. However, these indices were not measured due to the difficulty in measuring these indices accurately, objection by patients and cultural considerations.

5. Conclusion

Among the three anthropometric indices, CC is the most capable of predicting nutritional status, functional activity and general health conditions; MAC is the most capable of predicting 12-month follow-up mortality risk whereas BMI is the weakest in predicting all functions measured in this group of elderly Taiwanese.

Conflict of interest statement: None.

Acknowledgements

The authors wish to thank the personnel and residents of the institution for their cooperation during the course of this study. The authors also wish to thank the Department of Health of Taiwan for providing a grant-in-aid for this study. The study received no writing assistance in the preparation of this manuscript.

References

Allard, J.P., Aghdassi, E., McArthur, M., McGeer, A., Simor, A., Abdolell, M., Stephens, D., Liu, B., 2004. Nutritional risk factors for survival in the elderly living in Canadian long-term care facilities. J. Am. Geriatr. Soc. 52, 59-65.

Bonnefoy, M., Jauffret, M., Kostka, T., Jusot, J.F., 2002. Usefulness of calf circumference measurement in assessing the nutritional state of hospitalized elderly people. Gerontology 48, 162-169.

Burden, S.T., Stoppard, E., Shaffer, J., Makin, A., Todd, C., 2005. Can we use mid upper arm anthropometry to detect malnutrition in medical inpatients? A validation study. J. Hum. Nutr. Dietet. 18, 287-294.

Chumlea, W.C., 2006. Is the MNA valid in different populations and across practice settings? J. Nutr. Health Aging 10, 524-533.

Coelho, A.K., Rocha, F.L., Fausto, M.A., 2006. Prevalence of undernutrition in elderly patients hospitalized in a geriatric unit in Belo Horizonate, MG, Brazil. Nutrition 22, 1005-1011.

Deschamps, V., Astier, X., Ferry, M., Rainfray, M., Emeriau, J.P. Barberger-Gateau, P., 2002. Nutritional status of healthy elderly person living in Dordogne, France, and relation with mortality and cognitive or functional decline. Eur. J. Clin. Nutr. 56, 305-312.

Donini, L.M., Savina, C., Rosano, A., De Felice, M.R., Tassi, L., De Bernardini, L., Pinto, A., Giusti, A.M., Dannella, C., 2003. MNA predictive value in the follow-up of geriatric patients. J. Nutr. Health Aging 7, 282-293.

Donini, L.M., Savin, C., Rosano, A., Cannella, C., 2007. Systematic review of nutritional status evaluation and screening tools in the elderly. J. Nutr. Health Aging 11, 421-432.

Enoki, H., Kuzuya, M., Masuda, Y., Hirakawa, Y., Iwata, M., Hasegawa, J., Izawa, S., Iguchi, A., 2007. Anthropometric measurements of mid-upper arm as a predictor for community-dwelling Japanese elderly: the Nagoya Longitudinal Study of Frail Elderly (NLS-FE). Clin. Nutr. 26, 597-604.

Flodin, L., Svensson, S., Cederholm, T., 2000. Body mass index as a predictor of 1 year mortality in geriatric patients. Clin. Nutr. 19, 121-125.

Green, S.M., Watson, R., 2006. Nutritional screening and assessment tools for older adults: literature review. J. Adv. Nurs. 54, 477-490.

Inouye, S.K., Wagner, D.R., Acampora, D., Horwitz, R.I., Cooney, L.M., Hurst, L.D., Tinetti. M.E., 1993. A predictive index for functional decline in hospitalized elderly medical patients. J. Gen. Intern. Med. 8, 645-652.

Landi, F., Zuccala, G., Gambassi, G., Incalzi, R.A., Manigrasso, L., Pagano, F., Carbonin, P., Bernabei, R., 1999. Body mass index and mortality among older people living in the community. J. Am. Geriatr. Soc., 47, 1072-1076.

Lee, R.D., Nieman, D.C., 2003. Assessment of the hospitalized patient. In: Lee, R.D., Nieman, D.C., (Eds.). Nutritional Assessment, 3rd Ed. McGraw Hill, New York, pp. 216-250.

Lin, C.J., Liu, J.T., Chang, C.H., Nowalk, M.P., 2006. Association of obesity and chronic diseases in Taiwan. Asia. Pac. J. Pub. Health 18, 8-14.

Luchsinger, J.A., Lee, W., Carrasquillo, O., Rabinowitz, D., Shea, S., 2003. Body mass index and hospitalization in the elderly. J. Am. Geriatr. Soc. 51, 1615-1620.

Lunney, J.R., Lynn, J., Foley, D.J., Lipson, S., Guralnik, J.M., 2003. Patterns of functional decline at the end of life. J. Am. Med. Assoc. 289, 2387-2392.

Mason, C., Craig, C.L., Katzmarzyk, P.T., 2008. Influence of central and extremity circumferences on all-cause mortality in men and women. Obesity 16, 2690-2695.

Mazza, A., Zamboni, S., Tikhonoff, V., Schianvon, L., Pessina, A.C., Casiglia, E., 2007. Body mass index and mortality in elderly men and women from general population. Gerontology 53, 36-45.

Powell-Tuck, J., Hennessy, E.M., 2003. A comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalized patients. Clin. Nutr. 22, 307-312.

Reid, K.F., Naumova, E.N., Cararello, R.J., Phillips, E.M., Fielding, R.A., 2008. Lower extremity muscle mass predicts functional performance in mobility-limited elders. J. Nutr. Health Aging 12, 493-498.

Rolland, Y., Lauwer-Cances, V., Cournot, M., Nourhashemi, F., Reynish, W., Riviere, D., Vellas, B., Grandjean, H., 2003. Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. J. Am. Geriatr. Soc. 51, 1120-1124.

Seidell, J.C., Visscher, T.L.S., 2000. Body weight and weight change and their health implications for the elderly. Eur. J. Clin. Nutr. 54(Suppl 3), S33-S39.

Shibata, H., Haga, H., Nagai, H., Suyama, Y., Yasumura, S., Koyano, W., Suzuki, T., 1992. Predictors of all-cause mortality between ages 70 and 80: the Koganei Study. Arch. Gerontol. Geriatr. 14, 283-297.

Tajima, O., Nagura, E., Ishikawa-Takata, K., Ohta, T., 2004. Two new potent and convenient predictors of mortality in older nursing home residents in Japan. Geriatr. Gerontol. Int. 4, 77-83.

Tsai, A.C., Ku, P.Y., 2008. Population-specific Mini Nutritional Assessment effectively predicts the nutritional state and follow-up mortality of institutionalized elderly Taiwanese regardless of cognitive status. Br. J. Nutr. 100, 152-158.

Tsai, A.C., Chang, T.L., Yang, T.W., Chang-Lee, S.N. Tsay, S.F. 2010. A modified Mini Nutritional Assessment without BMI predicts nutritional status of community-living elderly in Taiwan. J. Nutr. Health Aging 14, 183-189.

Volpato, S., Romagnoni, F., Soattin, L., Ble, A., Leoci. V., Bollini, C., Fellin, R., Zuliani, G., 2004. Body mass index, body cell mass, and 4-year all-cause mortality risk in older nursing home residents. J. Am. Gerontol. Soc. 52, 886-891.

Wannamethee, S.G., Shaper, A.G., Whincup, P.H., 2004. Overweight and obesity and the burden of disease and disability in elderly men. Int. J. Obes. 28, 1374-1382.

WHO (World Health Organization), 1995. Physical Status: The Use and Interpretation of Anthropometry. World Health Organization Technical Report, no. 854. Geneva: WHO, 1995.

Woo, J., Ho, S.C., Sham, A., 2001. Longitudinal changes in body mass index and body composition over 3 years and relationship to health outcomes in Hong Kong Chinese age 70 years and older. J. Am. Geriatr. Soc. 49, 737-746.

Zhu, S., Heo, M., Plankey, M., Faith, M.S., Allison, D.B., 2003. Associations of body mass index and anthropometric indicators of fat mass and fat free mass with all-cause mortality among women in the First and Second National Health and Nutrition Examination Surveys Follow-up Studies. Ann. Epidemiol. 13, 286-293.

Table 1.
Characteristics of the subjects (n = 160)

Parameters	n(%)
Age groups (years)	
65-74	12 (7.5)
75-84	111 (69.4)
≥ 85	37 (23.1)
BMI (kg/m^2)	
< 21	75 (46.9)
21-23.9	53 (33.1)
24-26.9	21 (13.1)
≥ 27	11 (6.9)
MAC (cm)	
< 22.5	37 (23.1)
≥ 22.5	123 (76.9)
CC (cm)	
< 28	71 (44.4)
≥ 28	89 (55.6)
Smoking habits	
Never smoked	90 (56.3)
Current smoker	29 (18.1)
Past smoker	41 (25.6)
Alcohol drinking (≥ 1 times/week)	
Yes	9 (5.6)
ADL status[a]	
Mildly dependent	30 (18.8)
Moderately dependent	29 (18.1)
Severely dependent	28 (17.5)
Totally dependent	73 (45.6)
No. of chronic disease[b]	
0	68 (42.5)
1	42 (26.3)
2	34 (21.2)
≥ 3	16 (10.0)
No. of prescribed medication	
0	30 (18.8)
1-3	65 (40.6)
≥ 4	65 (40.6)
Length of hospital stay[c]	
0	88 (55.0)
1-5	13 (8.1)
≥ 6	59 (36.9)

Notes: [a]total score = 100. A score of 61-100 = mild dependency; 60-31 = moderate dependency; 15- = 30 high dependency; and ≤ 15 = total dependency. [b]including hypertension, heart disease, diabetes, dyslipidemia, respiratory disease, stroke, kidney disease, cancer and mental disorder. [c]during the past 6 months.

Table 2.
The average BMI, MAC and CC, and the proportion below the respective cut-off point in nursing elderly stratified by nutritional status graded with the MNA Taiwan Vers.-II, mean ± S.D., n(%)

Nutritional status BMI (< 21 kg/m^2)	MAC (< 22.5 cm)	CC (< 28 cm)
Normal (n = 42)		
22.82 ± 3.25^{b}, 13(31.0)	27.11 ± 2.24^{c}, 1(2.4)^{d}	32.54 ± 2.87^{c}, 0(0)
At risk of malnutrition (n = 87)		
21.34 ± 3.57^{a,b}, 42(48.3)	24.74 ± 2.94^{b}, 17(19.5)	27.75 ± 3.57^{b}, 44(50.6)
Malnourished (n = 31)		
20.18 ± 2.58^{a}, 20(64.5)	21.92 ± 2.30^{a}, 19(61.3)	24.24 ± 2.65^{a}, 27(87.1)

Notes: ^{a,b,c}Values not carrying the same superscripts within the same column are significantly different from each other ($p < 0.05$) on the basis of ANOVA and Scheffe post-hoc test.

Table 3.

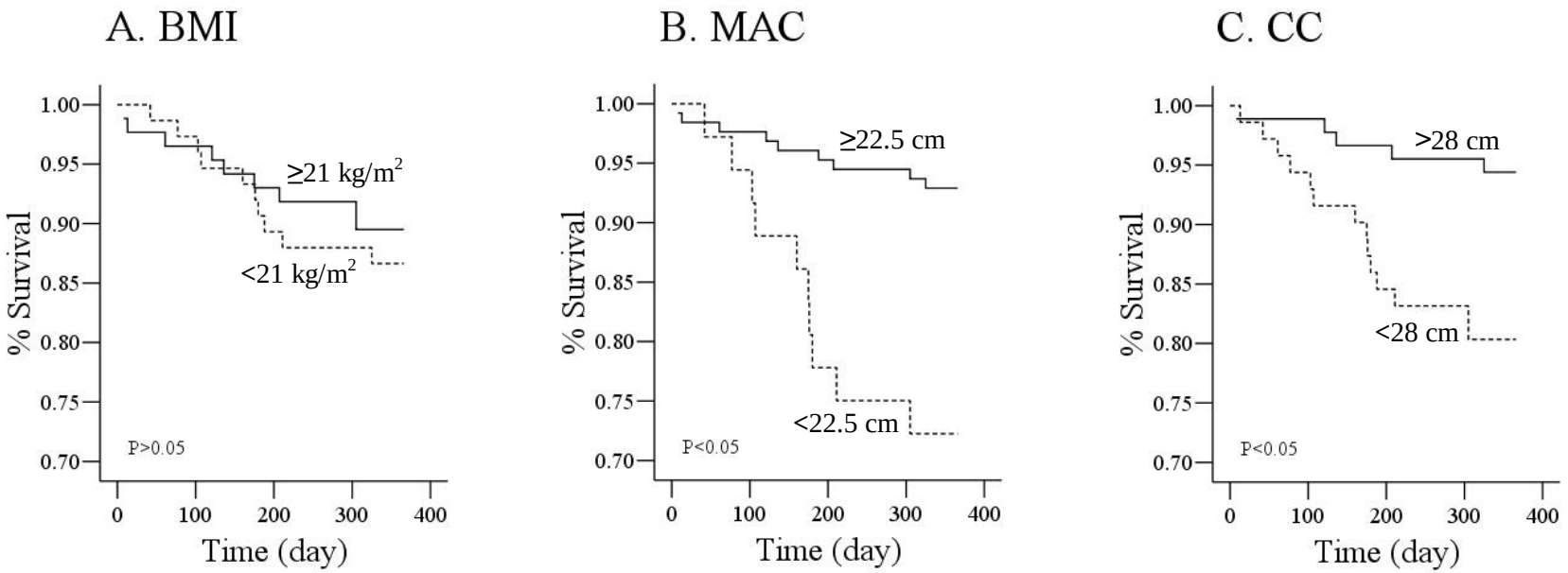
Spearman's correlation coefficients (r) of BMI, MAC and CC with various nutrition- or health-related indicators (n = 160)

Variables	BMI	p <	MAC	p <	CC	p <
Hemoglobin	0.297	0.001	0.414	0.001	0.395	0.001
Serum albumin	0.379	0.001	0.471	0.001	0.540	0.001
ADL score	0.283	0.001	0.449	0.001	0.624	0.001
No. of chronic diseases[a]	0.184	0.05	0.255	0.001	0.265	0.001
No. of emergency visits[b]	–0.143	0.072	–0.223	0.01	–0.235	0.01
Hospital length of stay[b]	–0.108	0.173	–0.205	0.05	–0.219	0.01

Notes: [a]Including hypertension, heart disease, diabetes, dyslipidemia, respiratory disease, stroke, kidney disease, cancer and mental disease. [b]During the past 6 months.

Fig. 1. Age-adjusted 12-month follow-up survival curves stratified by BMI (Chart A), MAC (Chart B) and CC (Chart C) cut-off points, respectively. Cox regression analysis showed significant differences in 12-month survival rates adjusted for age. The adjusted relative risks were 1:1.285 (95% CI = 0.521-3.167, p = 0.586) for subjects with BMI ≥ 21 vs. < 21 kg/m^2; 1: 4.377 (95% CI = 1.752-10.935, p = 0.002) for subjects with MAC ≥ 22.5 vs. <2 2.5 cm; and 1: 3.787 (95% CI = 1.364-10.518, p = 0.011) for subjects with CC ≥ 28 vs. < 28 cm.

(Fig. 1)


A. BMI
B. MAC
C. CC
% Survival
Time (day)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0
100
200
300
400
≥21 kg/m2
<21 kg/m2
P>0.05
≥22.5 cm
<22.5 cm
P<0.05
>28 cm
<28 cm
P<0.05