OPEN ACCESS Freely available online

HEALTHY AGING RESEARCH

Short form of the mini nutritional assessment is a better proxy for nutritional status in elderly than the body mass index: cross-sectional study

Davorka Vrdoljak [1*], Biserka Bergman Marković [2], Ksenija Kranjčević [2], Jasna Vučak [3], Dragica Ivezić Lalić [4]

1 Department of Family Medicine, University of Split School of Medicine, Split, Croatia **2** Department of Family Medicine, Zagreb University School of Medicine, Zagreb, Croatia **3** GP's Office, Sukošan, Croatia **4** GP's office, Health Center Novska, Rajić, Croatia

Abstract

Background: Malnutrition increases with age, but elderly nutritional status is difficult to ascertain and may be region-specific. The objective of this study was to define the cut-off value for body mass index (BMI) indicative of malnutrition in the elderly Croatian population.

***Methods*:** This was a cross-sectional study of the multicenter, randomized controlled trial conducted in 59 Croatian general practices between May 2008 - August 2010 (Cardiovascular Risk and Intervention Study in Croatia [CRISIC-fm], trial Registration Code: ISRCTN31857696). A total of 738 participants aged ≥ 65 were surveyed using a CRISIC-fm questionnaire, including the Mini Nutritional Assessment-Short Form (MNA-SF) scale and body weight and height. The association between BMI and MNA-SF was tested using the chi-squared test and contingency coefficient. Receiver Operating Characteristic Curve (ROC) analysis was used to assess predictive value of BMI for malnutrition in relation to MNA-SF and ROC curve to determine the best cut-off value of BMI relative to the MNA-SF.

***Results*:** Twelve (2.4%) participants were "at risk of malnutrition" by the MNA-SF. ROC curve indicated that a BMI threshold as high as 26.5 kg/m^2 is needed to identify 66% of these "at risk for malnutrition" elderly according to the MNA-SF (area under the curve [AUC]: 0.80, $P<0.001$). A BMI cut-off value of 24.5 kg/m^2 has a sensitivity of 50% and a specificity of 86%.

***Conclusion*s:** Higher BMI values, up to 24.5 kg/m^2, should be considered as thresholds for better detecting elderly malnutrition. The current BMI cut-off value (<18.5 kg/m^2) is not applicable to elderly Croatians.

Citation: Vrdoljak D, Marković BB, Kranjčević K, Vučak J, Lalić DI (2014) Short form of the mini nutritional assessment is a better proxy for nutritional status in elderly than the body mass index: cross-sectional study. Healthy Aging Research 3:9. doi:10.12715/har.2014.3.9

Received: October 28, 2014; **Accepted:** November 28, 2014; **Published:** December 9, 2014

Competing interests: The authors have declared that no competing interests exist.

* Email: davorka.vrdoljak@mefst.hr

Introduction

Malnutrition is a term that covers all aspects of imbalance between nutrient intake and body requirements and includes both under- and over-nutrition (overweight and obesity, respectively) [1]. The prevalence of malnutrition increases with age, especially in people over the age of 65 [2]. Malnutrition increases the risk of functional impairment, disability [3] and dependency on others and therefore, should be avoided to maintain independence, autonomy and quality of life in the elderly as long as possible.

A number of diseases, including osteoporosis, deficient anemia and cognitive disorders are linked to malnutrition and reduced intake of micronutrients. People with malnutrition have longer hospital stays, their wounds are more difficult to heal, they have slower recoveries from surgical procedures and bone fractures, and are more prone to bed sores and other complications [4]. Morbidity and mortality risks are increased in those with malnutrition when compared to their adequately nourished peers [5,6].

It is important to acknowledge that there is still no "gold standard" for the determination of malnutrition in the elderly, and that the nutritional status of the elderly is difficult to assess [2]. According to the U.S. project, Nutritional Screening Initiative (NSI), the assessment of nutritional status of the elderly is defined by A - anthropometric measurements, B - biochemical parameters, C- clinical examination, D– dietary, i.e. nutritional assessment, E - empathy and F - functional status (ABCDEF) and should be regularly performed by general practitioners (GPs) in community-dwelling elderly [7].

Anthropometry is a simple, non-invasive and inexpensive method that is often used in everyday clinical practice and enables calculation of the body mass index (BMI) as a ratio of weight (kg) and squared height of a person (m^2). It was first used in an epidemiological study in 1972 and, two decades later, accepted as the gold standard method by the World Health Organization (WHO) as a statistical measure of overweight and obesity in adults [8-10]. BMI, however, does not take into account the structure of the body or the percentage and distribution of adipose tissue, both of which change as a person ages [11,12]. It also does not reflect changes that may occur due to sarcopenia (loss of skeletal muscle mass) or decrease in stature (osteoporosis, degenerative changes in the vertebrae and vertebral discs thinning) [13], thus masking important weight changes and resulting in the failure to recognize malnutrition in time.

Seeking to identify nutritional disorders in people aged ≥ 65 years better, the Mini Nutritional Assessment (MNA) Scale and its short form (MNA-SF) were created and validated in the elderly population in many European countries[14] . The original MNA scale consists of 18 items: four anthropometric data (BMI, upper arm circumference and calf circumference, loss of weight in the last three months), six functional status assessment data (medication, the independence in activities of daily living, bed sores or their pre-stages, cognitive status), six dietary data (number of daily meals, number of protein meals, fruit and vegetable intake, reduced appetite, hydration, feeding autonomy), and two issues on self-assessment (self-perception of nutritional and health status compared to peers). The MNA-SF is comprised of six items (food intake decline due to loss of appetite, digestive problems, chewing or swallowing difficulties, weight loss in the last 3 months, mobility, psychological stress, neuropsychological problems and BMI) and used as standalone tool. It has been shown that MNA-SF has sufficient sensitivity and specificity even when compared to the full MNA. The specificity and sensitivity of the MNA-SF scale in detecting non-institutionalized, malnourished elderly patients were estimated at 96% and 89%, respectively [14-16].

Due to anthropometric differences between populations of some countries and variations among different ethnic groups, the WHO Expert Committee advised that each member country should regularly collect its own data on the anthropometric characteristics of their populations and calculate the BMI threshold values [17]. For this reason, we aimed to collect data on nutritional status in elderly Croatians and to redefine the currently used cut-off values for this population.

Methods

Sample and participants

The sample for this study was selected from the Cardiovascular Risk and Intervention Study in Croatia (CRISIC-fm) (ISRCTN 31857696), which included participants of both sexes aged ≥ 40 years. In order to investigate the nutritional status of the elderly, we only selected participants aged ≥ 65 years. The target population for this part of the study included citizens of Croatia who visited their GP for any reason from May 2008 to August 2010. Participants with communication disabilities (dysphasia, aphasia), severe dementia or severe mental illness and those with estimated life expectancies of less than six months were excluded from the target population. Enlisting of the participants was done in two phases. In the first phase, the 4-stage, disproportionate stratified random sampling of general practices was created. The sample of general practices was stratified based on 21 Croatian counties and 2 regions (coastal, continental). Coastal regions included practices on islands and in villages and towns up to 30 km away from the sea, if there was no natural obstacle, such as a hill or mountain, between them. Further stratification was performed into five strata according to the settlement size (up to 3999 inhabitants, 4000 to 9999, 10000 to 29999, 30000 to 89999 and 90000 inhabitants or more; settlements with < 4000 inhabitants were defined as villages, while those with ≥ 4000 were defined as a town). Finally, the sample was stratified into three strata based on the number of insured people in a GP's care having a contract with the Croatian Institute for Health insurance (CIHI) in 2007 (≤ 1399, 1400 – 1799, ≥ 1800). Within each stratum, GP offices were randomized and selected by a random number generator from the list of all contracted CIHI general practices in 2007. For each physician initially contacted, a reserve sample of two additional GPs was made, according to the four-fold stratum. If a GP refused to participate, the most closely located GP from a reserve sample was invited. All GPs were verbally informed in detail about the study and then signed a consent form to participate in the research. The sample size was calculated to reach 95% confidence interval and the desired power of statistical tests. Of the 82 GPs invited to participate in this study, 64 of them accepted (78%); however, five declined participation following the first follow-up, so the total number of GPs in the final sample was 59.

In the second stage, each GP chose a systematic, disproportionate sample of the first 55 patients who visited the practice for any reason from the day the study began, and who met the inclusion criteria and confirmed by written consent. All the participating GPs included the same number of patients (n=55), regardless of the total number of insured people they have contracted with CIHI, and the total number of patients from the target population they examined. This was corrected by post-hoc weight factors prior to statistical analysis. Out of 82 eligible GPs, 64 accepted to participate and five withdrew at first follow-up. Out of 992 patients aged ≥65 years that were assessed for eligibility and invited to participate in the study, 738 patients completed the study as shown in Fig. 1.

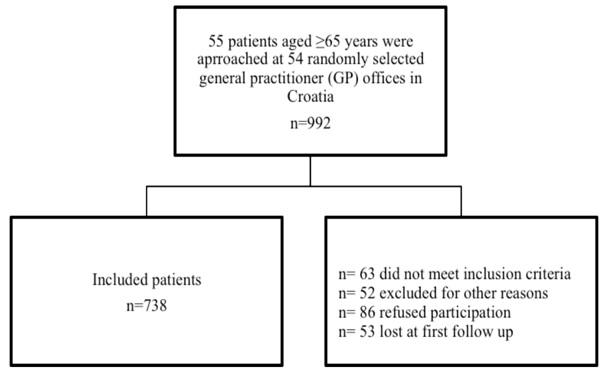

Figure 1. Flow chart of participant inclusion into the study

Questionnaire and measurements

For all participants, the CRISIC-fm questionnaire, designed for the purpose of this study, was used. It included the MNA-SF rating scale and BMI calculation. The MNA-SF includes two steps: the screening (MNA-SF1) and assessment scales (MNA-SF2), the latter of which is used only if the MNA-SF1 score is 11 points or below. Total malnutrition indicator score (MNA-SF1+MNA-SF2) in range 17-23.5 indicated a risk of malnutrition, and < 17 signaled that malnutrition was already present. Participants' body weights and heights were measured twice using identical standardized scales, and BMI was calculated from weight (kg) divided by the square of body height (m^2).

Statistical analyses were carried out with Statistical Package for Social Science (SPSS) for Windows version 17.0 (SPSS IBM, Inc., Chicago, IL, United States). The association between BMI and MNA was tested using χ^2-test and contingency coefficient. Receiver Operating Characteristic Curve (ROC) analysis was used to assess predictive value of BMI in detecting malnutrition in relation to MNA-SF and ROC curve to determine the best cut-off value of BMI in relation to MNA. Significance was set at $P<0.05$.

Ethics

The work has been approved by ethical committees of the University of Split School of Medicine and Zagreb University School of Medicine. All participation was voluntary and included signing of the consent form.

Results

Nutritional status

The whole sample of participants consisted of 248 (38.6%) males and 452 (61.4%) females, of which 535 (72.5%) and 203 (27.5%) were living in urban and rural settlements, respectively. According to BMI, 4 (0.5%) were undernourished, 133 (18.2%) had normal BMIs, 329 (45.1%) were overweight and 265 (36.2%) obese. According to the screening scale scores (MNA- SF1), 102 (18.9%) of older patients required further nutritional status testing by using assessment scale (MNA- SF2). Of those, only 12 (2.4%) participants were rated as "at risk of malnutrition". Most participants (81%) did not require further MNA-SF assessment after the screening questions, because the MNA-SF1 determined that they were not at risk of malnutrition. The remaining subjects filled out the other part of the MNA-SF scale and the overall result was obtained. The results were grouped into three categories according to the number of points (Table 1).

Table 1. Total MNA-SF (MNA-SF1+MNA-SF2) in the whole sample

		n	(%)
Total MNA-SF (MNA-SF1+MNA-SF 2) divided in 3 nutritional categories*	at risk	12	(2.4)
	normal	504	(97.6)
Total		517	(100.0)

MNA-SF: Mini Nutritional Assessment short form

MNA-SF1 + MNA-SF 2 = total malnutrition indicator score; ≤17 malnourished, 17-23,5 "at risk of malnutrition", >23.5-30 normally nourished
*total result is grouped into 3 categories according to the number of points

Association of BMI and MNA

Contingency coefficient showed a statistically significant positive correlation between BMI and MNA (r = 0.31, *P* <0.001). Eight percent of the respondents who were at risk of malnutrition according to MNA were also malnourished according to BMI, and no participants were obese (Table 2). Among participants with normal nutritional statuses, none were malnourished according to both the MNA-SF and BMI, indicating that the categories completely overlap.

Table 2. BMI and MNA-SF in the whole sample

		Total MNA-SF (MNA-SF1+MNA-SF2) divided in 3 nutrition categories			
		At risk		Normal NS	
		n	(%)	n	(%)
BMI (kg/m^2)	Malnourished (<18.5)	1	(7.9)		
	Normal (18.6-24.9)	5	(42.6)	88	(17.6)
	Overweight (25-30)	6	(49.5)	228	(45.6)
	Obese (>30)			185	(36.9)
Total		12	(100.0)	501	(100.0)

BMI: Body Mass Index

MNA-SF: Mini Nutritional Assessment scale, short form

NS: nutritional status

Receiver Operating Characteristic Curve Analysis

Due to the large percentage of normally fed and overweight participants according to BMI who were deemed "at risk of malnutrition" according to the MNA-SF, it seems that the MNA-SF is a better detector of risk, but it is possible that it has a lower sensitivity because it did not identify any malnourished participants, thus reducing the correlation coefficient. A detailed comparison was not possible because BMI has four categories and the MNA-SF has only two; because it did not detect the malnourished, the third category is missing.

Therefore, Receiver Operating Characteristic Curve (ROC) analysis was performed, taking the MNA-SF scale as a validity criterion for detecting malnutrition in the elderly population, and BMI as the other possible criterion for which we wanted to check in terms of sensitivity and discriminability. Area under the curve (AUC) indicates the relationship between sensitivity (ability to detect subjects with a nutritional disorder) and specificity (ability to correctly classify "normal" as those without a nutritional disorder) and shows how good a measure is compared to the "gold standard" or objective criteria, which, in our case, is the MNA-SF.

We found that the BMI cut-off value should be increased to 26.5 kg/m^2 in order to identify 66% of respondents revealed by the MNA-SF to be "at risk" and classify them as malnourished (Table 3). That would allow for the highest sensitivity and specificity of BMI, about 70%, and make the AUC 0.80 (P <0.001) (Fig. 2).

As the BMI of 26.5 kg/m^2 already exceeds the "normal" category of weight to "overweight", it would be considered excessive in younger populations. Therefore, the calculated sensitivity and specificity for the threshold BMI is 24.5 kg/m^2 with a slightly lower sensitivity at 50% and specificity at 86%, which is more appropriate.

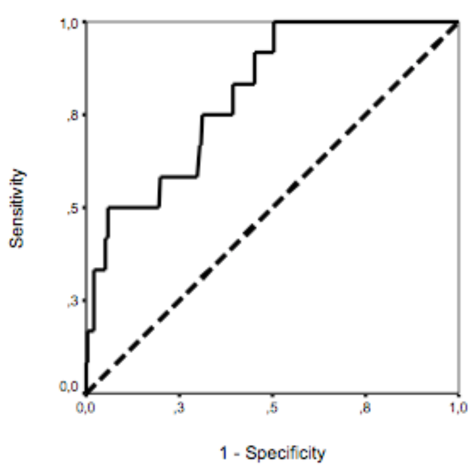

Figure 2. Receiver operating characteristic curve (ROC) showing sensitivity and specificity of BMI in identifying malnutrition in participants aged ≥ 65 years (thick full line)*

*Diagonal line indicates the hypothetical ideal sensitivity and specificity

Discussion

BMI is the most commonly used anthropometric tool for monitoring of populations' nutritional, functional and health statuses; however, its cut-off values for the elderly population need to be determined to correctly reflect changes that occur with the aging of individuals. Consistent with these recommendations, we analyzed BMI numbers and MNA-SF results of a representative sample of the elderly Croatian population enlisted for GPs. We found that the BMI threshold value for malnutrition in the elderly in the Republic of Croatia should be set to 24.5 kg/m^2.

In a study conducted by the group of Brazilian researchers, who compared BMI and MNA in hospitalized elderly, the BMI threshold for malnutrition was suggested to be set at an even lower value - 23.2 kg/m^2 - than the one we report here [18]. Sergi *et al.* proposed a BMI value of 20 kg/m^2 as a threshold to determine underweight elderly Italians [19], while the optimal BMI for older American people is set much higher, to 24-29 kg/m^2 [20]. Moreover, Allison *et al.* showed that minimum mortality occurred at a BMI of approximately 31.7 kg/m^2 in men and 28.8 kg/m^2 in women aged 70 and over [21].

Research on nutritional disorders in populations aged ≥ 65 in Europe is primarily conducted on a sample of hospitalized and institutionalized persons (in homes for elderly people and retirees). Studies on populations of this age living independently in their own homes in the community are very rare. Depending on the study, the prevalence of malnutrition is 25-60%; in institutionalized elderly it is 35-65%; in hospitalized elderly, it is 35-65%; and it is much lower, about 1-5%, in community-dwelling elderly [22-24]. In our study, none of the participants had a total malnutrition indicator score below 17 points, so there were no undernourished elderly in our sample, very similar to research from Beck *et al.* conducted in Danish general practice setting [25]. The percentage of elderly detected as "at risk of malnutrition" using the MNA-SF in our study was rather low, 2.4% of which can be explained by an absence of homebound and recumbent elderly in our study sample.

Table 3. Predictive value of BMI and MNA-SF in detecting malnutrition in people aged ≥ 65 years

		AUC	95% CI	Std. Error	*P*	Best cut-off	Sensitivity (%)	Specificity (%)
Malnutrition according to MNA-SF	BMI, cut-off 26	0.807	0.702-0.913	0.054	<0.001	26.5	67%	69%
	BMI, cut-off 24	0.807	0.702-0.913	0.054	<0.001	24.5	50%	86%

AUC: area under the curve

MNA-SF: Mini Nutritional Assessment short

Namely, the study involved only insured populations aged ≥ 65 years in the care of a GP, who met criteria for inclusion and personally visited the GP practice during a given period. Thus, the recumbent and immobile elderly patients who were unable to come to the doctor's office and those who were not insured with CIHI (about 3% of Croatian population) could not participate in the sample. In effect, these are two limitations of our study. For these reasons, the sample does not fully reflect the average Croatian population aged ≥ 65 years, but it does accurately represent the population of elderly in the GP's care.

Conclusions

Many studies suggest that routine nutritional screening of the elderly should become a routine procedure in order to detect nutritional problems or malnutrition better and improve the nutritional care for this population [26-28]. In this study using the MNA-SF, we identified 2.4 % of older people in the GP's care at risk for malnutrition. We also compared BMI and the MNA-SF in predicting malnutrition. According to our data, it appears that BMI reference ranges and current thresholds for the normal nutrition and malnutrition of younger adults are not completely applicable to the elderly. They should be redefined so that older people with BMI <24.5 kg/m^2 in Croatia are already considered to be "at risk of malnutrition". When identified, they should be carefully followed up; the cause of malnutrition should be investigated and/or corrected when necessary nutritional deficiencies are present in order to achieve better health outcomes in the elderly.

A higher BMI threshold for the under-nutrition of the elderly could help diagnose the risk of malnutrition in an earlier stage and prompt intervention or treatment before severe malnutrition and its consequences actually develop.

Acknowledgements

We would like to thank all of the participants and their general practitioners for their participation in the study.

References

1. Chen CC-H, Schilling LS, Lyder CH. A concept analysis of malnutrition in the elderly. J Adv Nurs. 2001;36:131-42.
2. Bauer JM, Kaiser MJ, Sieber CC. Evaluation of nutritional status in older persons: nutritional screening and assessment. Curr Opin Clin Nutr Metab Care. 2010;13:8-13.
3. Saka B, Kaya O, Ozturk GB, Erten N, Karan MA. Malnutrition in the elderly and its relationship with other geriatric syndromes. Clin Nutr. 2010;29:745-8.
4. Cabrera M, Mesas A, Garcia A, de Andrade S. Malnutrition and depression among community-dwelling elderly people. J Am Med Dir Assoc 2007;8:582–4
5. Flegal MF, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. JAMA. 2005;293:1861-7.
6. Corrada MM, Kawas CH, Mozaffar F, Paganini-Hill A. Associtiion of Body Mass Index and Weight Change with All_cause Mortality in the Elderly. Am J Epidemiol. 2006;163:938-42.

7. Dwyer J. Strategies to detect and prevent malnutrition in the elderly: the Nutrition Screening Initiative. Nutr Today. 1994;29:14-24.
8. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser. 1995;854:1-452.
9. Global Database on Body Mass Index [Internet]. Geneva: World Health Organization. c2006 – [cited 2012 Jul 27]. Available from http://www.who.int/bmi/index.jsp?introPage=intro_3.html
10. World Health Organisation. Obesity: preventing and managing the global epidemic. 1998, WHO, Geneva (WHO Technical report 894)
11. Goodpaster BH, Park SW, Harris TB, et al. The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. J Gerontol A Biol Sci Med Sci. 2006;61:1059-1064.
12. Hughes VA, Roubenoff R, Wood M, Frontera WR, Evans WJ, Fiatarone Singh MA. Anthropometric assessment of 10-y changes in body composition in the elderly. Am J Clin Nutr. 2004;80:475-482
13. Gallagher D, Ruts E, Visser M, Heshka S, Baumgartner RN, Wang J, et al. Weight stability masks sarcopenia in elderly men and women. Am J Physiol Endocrinol Metab. 2000;279:366–75.
14. Guigoz Y, Vellas BJ, Garry PJ. The Mini Nutritional assessment (MNA): a practical assessment tool for grading the nutritional state of elderly patients. In: Vellas BJ, Guigoz Y, Garry PJ, Albarede JL (Eds). Nutrition in the Elderly-Gerontology. 2nd Ed. Paris: Serdi. p. 15-61.
15. Guigoz Y, Laque S, Vellas BJ. Identifying the elderly at risk for malnutrition. The Mini Nutritional Assessment. Clin Geriatr Med. 2002;18:737-57.
16. Rubenstein LZ, Harker JO, Salvia A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Med Biol Sci. 2001;56:366-72.
17. De Onis M, Habicht JP. Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee. Am J Clin Nutr. 1996;64:650-8.
18. Leandro-Merhi VA, de Aquino JL, de Camargo GT J. Agreement between body mass index, calf circumference, arm circumference, habitual energy intake and the MNA in hospitalized elderly. J Nutr Health Aging. 2012;16:128-32.
19. Sergi G, Perssinotto E, Pisent C, Buja A, Maggi S, Coin A, et al. An adequate treshold for body mass index to detect underweight condition in elderly persons: the Italian Longitudinal Study on Aging (ILSA). J Gerontol A Biol Sci Med Sci. 2005; 60:866-71.
20. Ham RJ. Indicators of poor nutritional status in older Americans. Am Fam Physician. 1992;45:219-28.
21. Allison DB, Gallagher D, Heo M, Pi-Sunyer FX, Heymsfield SB. Body mass index and all-cause mortality among people age 70 and over: the Longitudinal Study of Aging. Int J Obes Relat Metab Disord. 1997;21:424-31
22. Thorslund S, Toss G, Nilsson I, v Schenk H, Symreng T, Zetterqvist H. Prevalence of protein-energy malnutrition in a large population of elderly people at home. Scand J Prim Health Care. 1990;8:234-8.
23. Visvanathan R; Macinthosh C, Calary M, Penhall R, Horowitz M, Chapman I. The nutritional status of 250 older Australian recipients of domiciliary care services and its association with outcomes at 12 month. J Am Geriatr Soc. 2003;51:1007-11.
24. Bauer JM, Volkert D. Nutritional assessment in the European community. In: Morley JE, Thomas Dr, editors. Geriatric nutrition. Boca Raton, London, New York: CRC Press; 2007:235-48.
25. Beck AM, Ovesen L, Schroll M. A six months' prospective follow-up of 65+ years old patients from general practice classified according to nutritional risk by the Mini Nutritional Assessment. Eur J Clin Nutr. 2001;55:1028-33.
26. Elia M, Zellipour L, Stratton RJ. To screen or not to screen for sult malnutrition? Clin Nutr. 2005;24:867-84.
27. Moore AA, Siu A, Partridge JM, Hays RD, Adams J. A randomized trial of office-based screening for common problems in older persons. Am J Med.1997;102: 371-8.
28. Engelhardt JB, Toseland RW, O'Donnel JC, Richie JT, Jue D, Banks S. The effectiveness and efficiency of outpatient geriatric evaluation and management. J Am Geriatric Soc. 1996;44:847-56.