Nutritional status related to poor health outcomes in older people - which is better, obese or lean?

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Short running title: Obese or lean?

Abstract

Good nutritional status is crucial for maintaining growth and health in all stages of life. However, the relationship between nutritional status and health and the effect on various health-related outcomes differ, depending on the life stage. Many adverse outcomes in older adults, directly linked to different nutritional status, are not present in middle-aged adults, and their ideal nutritional status may differ. This article will review the optimal nutritional status, mainly evaluated by anthropometric measurements such as body mass index (BMI), for older adults from various perspectives. Overall, in the older adults low BMI is at higher risk of health problems such as mortality and difficulties in physical functioning compared to middle-aged adults, reducing the risk of health problems for overweight and (abdominal) obesity. Overweight may be more beneficial than lower level of normal weight in the older-old and vulnerable older people. On the other hand, with or without obesity, skeletal muscle loss or weakness as well as unintentional weight loss induce health problems in the older adults. The impact of metabolic syndrome on the prognosis of the older adults is clearly reduced compared to middle-aged adults, requiring a shift from metabolic syndrome to frailty, especially the concept of frailty becoming important over the age of 75. There are still many unclear points regarding the optimal nutritional status of the older people, and further research is needed to support the healthy longevity.

Keywords: body mass index, disability, mortality, nutrition, older adults

Introduction

The aging rate is rising in many countries and the older population is increasing worldwide. There is concern that medical and long-term care costs will rise due to the increase in the number of older patients, leading to further increase in social security costs. Moreover, the older adults do not only want longevity, but also, to be independent and healthy. Therefore, it is necessary to take measures to extend the independence and healthy period (healthy life expectancy) of older people, entirely. The nutritional status of older adults influences the processes leading to the development of new diseases, requiring long-term care, and is extremely important when considering the extension of healthy life expectancy.

On the other hand, it is not well understood whether the optimal nutritional status for poor health outcomes such as mortality and physical dysfunction related to healthy life expectancy in the older adults is different or the same as that in middle-aged adults. To clarify these questions, this article reviews the following important issues in considering nutrition for older adults: 1) Changes in body composition, physical activity, energy consumption, and intake with aging, 2) Anthropometric measurements as nutritional evaluation, 3) Anthropometric measurements and poor health outcomes, 4) Other important nutrition-related matters for older adults, 5) Diet intervention for lifestyle-related diseases and risk of frailty in older patients, 6) Transition of nutritional management- shift of metabolic syndrome to frailty.

Changes in body composition, physical activity, energy consumption, and intake with aging

Total energy expenditure (TEE) decreases in healthy older adults, and physical activity and basal metabolic rate accounted for 46 and 44% of this decrease, respectively [1)]. It is believed that the decrease in basal metabolism in older adults is due to the decrease in lean body mass, 70% of which is composed of muscle. Weight loss is also observed around age 50 in both men and women. In addition, with the decrease in energy consumption, energy intake also decreases with aging [2)]. One of the mechanisms of the physiological decline of energy intake in older people (anorexia of aging) is due to appropriate response to the reduced energy needs and expenditures.

It has also been reported that 10-12% of the older adults have protein intake below the estimated average requirement set by each country [3)]. This reduction in protein intake increases the risk of developing sarcopenia and frailty.

Figure 1 shows energy and macronutrient intake by age group from 50 to ≥80 years based on 2018 Japanese National Health and Nutrition Survey [4)]. Total energy intake per day decreases during aging, especially after 80 years and older. Except for carbohydrate, protein and lipid intake decrease gradually after 60 years. Percentage of energy from the lipid decreases with age, in contrast to that from carbohydrate, while the percentage from protein is relatively constant.

Anthropometric measurements as nutritional evaluation

a) Changes with aging

The most frequently used method for assessing nutritional status is the body mass index (BMI). It is calculated by dividing weight (kg) by height (m) squared. BMI provides a stature-independent measure of body weight and a surrogate measure of total body fat. The current nutritional status based on a balance between energy intake and expenditure is best measured by a surrogate of body energy stores, or, BMI. In older adults, the height shrinks from around the age of 50 due to changes in posture, joint space narrowing, and thinning of the intervertebral disc with age. It is reported that between the ages of 30 and 80, the height of both men and women will be reduced by an average of 5 cm and 6.2 cm, respectively [5)].

For example, as shown in table 1, if a man with a height of 170 cm and weight of 70 kg at the age of 30 shortens by 5 cm (165 cm) at the age of 80, BMI naturally increases even if there is no change in weight. The same situation occurs in women of age 80 who shorten by 6.2 cm. Based on these facts, there is a possibility that the nutritional status of older persons may be misjudged if evaluated only by BMI. Nevertheless, BMI is still being used in research and clinically as an indicator of nutritional status. Given that most nutrition screening or assessment tools for older people target undernutrition, BMI has the merit that it can be used as an evaluating index that covers overnutrition to undernutrition. In addition, BMI can be applied to studies that compare the effects of nutritional status on various incident diseases and life prognosis, from children to the older people. The benefits of using limb anthropometric values as nutritional indicators have also been proven [6)], but these indicators are mainly used in research, and not clinically, at a similar frequency as

BMI.

Besides, many reports agree that not only body weight and BMI, but also abdominal obesity as an index of physique, have a great influence on disease onset and physical dysfunction. The waist circumference (WC) or waist-hip-ratio is often used as an index.

b) Differences in BMI distribution among older people by country

It is clear that the population distribution of BMI varies greatly, by ethnicity and race. The proportion of overweight and obese people in the population also varies greatly per country. The highest prevalence of obesity (BMI $\geq$30 kg/m^2) in adults according to the Organisation for Economic Co-operation and Development member country in 2015 was 38.2% in the United States (US), while the lowest was 3.7% in Japan [7)]. In addition, it has been reported that the BMI cut-off point for obesity, as estimated by distribution of glucose and lipid factors, is lower by 6-10 kg/m^2 among non-European groups compared with Europeans [8)]. It was also reported that Asian populations have a higher risk of developing comorbidities such as cardiovascular disease (CVD) and type 2 diabetes at BMIs lower than 25 kg/m^2 (WHO cut-off point for overweight) [8,9)], since Asians have a high percentage of body fat at a low BMI. Therefore, the criteria for BMI of overweight and obesity may differ between Western and Asian countries [9)].

According to a 2007-2010 survey in the US, the prevalence of obesity was 40.8% in older adults aged 65-74 years and 27.8% in older adults aged 75 years and older [10)]. Meanwhile, according to the 2016 National Survey in Japan, the prevalence rates of obesity in people over 65 and 80 years were 3.6% and 2.8% respectively [11)]. Thus, the proportion of obesity varies greatly by race and country, and the health outcomes may differ, depending on the BMI level; therefore, careful interpretation is necessary.

Anthropometric measurements and poor health outcomes

a) BMI

i) Mortality

The meta-analysis based on 239 prospective studies in four continents has revealed that the hazard rations (HRs) of all-cause mortality for overweight (BMI 25 to <30 kg/m^2) and obesity grade 1 (BMI 30 to <35 kg/m^2) were broadly similar across different geographical regions. In each region, BMI was non-linearly associated with all-cause mortality, with the nadir at BMI 20.0 kg/m^2 to <25.0 kg/m^2 [12]. Interestingly, as described above, the relationship between metabolic risk such as the onset of type 2 diabetes and BMI value differs in Western and Asian countries [8,9], but the relationship between all deaths and BMI, in particular, the range of BMI with the lowest mortality risk, does not seem to differ greatly between Western and Asian countries.

The optimal BMI value with a low mortality risk as well as the rate of increase in mortality risk associated with an increase in BMI varies, depending on the age [12-14]. Regardless of race, the HRs of all-cause mortality for overweight and obesity were higher in younger ages than in older ages [12,13].

Although the distribution of BMI in the older adults varies by race (it is higher in Europe and the US and lower in Asian countries), the association of BMI ≥ 25 kg/m^2 with all-cause mortality was approximately log-linear, and of similar strength in each region [12,13]. However, the bottom value of the risk varies, depending on the report. A meta-analysis of 32 cohort studies of community-dwelling older people aged 65 and older from the Western countries demonstrated that the estimated nadir of all-cause mortality is between 27.0 and 27.9 kg/m^2 [15]. Another meta-analysis including 239 prospective studies in four continents has reported that the nadir BMI depended on age: 22 kg/m^2 for baseline age 35-49 years, 23 kg/m^2 for baseline age 50-69 years, and 24 kg/m^2 for baseline age 70-89 years [12]. A large population-based cohort study in the United Kingdom estimated that the lowest risk of all-cause mortality for those below age 70 was 23 kg/m^2, and age 70 and above was 25 kg/m^2 [16]. Furthermore, the degree of increase in mortality risk associated with elevated BMI is also decreasing in the older adults [15]. However, multiple prospective studies of community-dwelling older people, observed that elevated BMI, overweight, and obesity of older people are not mortality risks [17-19].

The meta-analysis of 20 studies on the prognosis and BMI of the older adults in nursing homes reported that compared with normal weight, all-cause mortality HR were 1.41 for underweight (BMI <18.5kg/m^2), 0.85 for overweight (BMI 25 to <30kg/m^2), and 0.74 for obesity (BMI ≥ 30kg/m^2). Underweight was associated with a significant increased risk of mortality caused by infection and CVD. Conversely, overweight and obesity did not affect any of the specific-cause mortality events [20]. In addition, many studies examining the relationships between BMI and all-cause mortality demonstrated that higher BMI is associated with lower mortality risk, and lowest mortality risk was observed in older hospitalized obese patients with BMI ≥ 30kg/m^2 [21,22].

In conclusion, for many countries including Asia, older populations tend to exhibit a reverse J-shaped or L-shaped association between BMI and all-cause mortality. Consistent result shows that lower BMI than normal increases the risk of all-cause mortality of older adults in the community and various clinical settings (Table

2). Older people with a higher BMI and a lower risk of death appear to be the more vulnerable ones in hospitals or nursing homes, rather than community-dwelling ones.

ii) Difficulties in physical functioning

It is well known that there is a strong association between middle-aged adult obesity and mobility and physical disability, and disability-adjusted life-years [23]. However, the cross-sectional relationship between BMI and physical disability in older adults is controversial. Possibly, this discrepancy is due to age, comorbid effects, degree of ADL disorder, and involvement of abdominal obesity [24,25].

Many prospective studies targeting older people have suggested that the risk of ADL disability and BMI is a U-shape relationship. For example, in a 7-year prospective study of older people aged 65 years and older in the US, those with BMI 25-29.9 kg/m^2 had the lowest risk of disability, and participants with BMI <18.8 or ≥ 30 kg/m^2 had significantly increased risk [26]. In the Rotterdam Study cohort with an average age of 68.8 years and a 6-year follow-up period, elevated BMI is not a mortality risk, but a risk of ADL disability compared to normal BMI (18.5 to <25 kg/m^2) [17]. In a Japanese cohort study of community-dwelling older people aged 65 years and older (an average of 5.7 years follow-up), the relationship between BMI and incident functional disability, which is defined as Long-term Care Insurance certification, was U-shape, and the lowest risk was BMI 26 kg/m^2 [27]. This study also analyzes the relationship between case-specific disability and BMI. The lowest-risk optimal BMI was 28 kg/m^2, 25 kg/m^2, and 23 kg/m^2 for incident disability related to dementia, stroke, and joint disease, respectively. Low BMI (<23 kg/m^2) was a risk of disability due to dementia, and high BMI (≥ 29 kg/m^2) was a risk of disability due to joint disease. Therefore, a BMI of 23 to <29 kg/m^2 was proposed to be optimal for the community-dwelling older people, as it does not pose any case-specific disability risk in the range investigated [27].

In a cohort study of Chinese older people (mean age 92.2 ±7.2 years, and mean BMI 19.3 ±3.8 kg/m^2), the BMI was linearly and inversely associated with risk of ADL disability. The underweight group (BMI <18.5 kg/m^2) showed significantly increased risk of disability in ADL and the overweight or obese group (BMI ≥24.0 kg/m^2 according to Chinese guideline) showed significantly decreased risk compared with the normal weight group (BMI 18.5 to <24.0 kg/m^2) [28].

From the above, although not all studies agree, obesity and lower weight seem to be a risk for functional disability in older adults compared to normal BMI, also, overweight is likely to reduce the risk of ADL disability (Table 2).

b) Abdominal obesity

i) Mortality

Visceral fat accumulation (abdominal obesity) has been established as an important indicator of the risk of developing various lifestyle-related diseases and CVD in middle-aged adults, as well as death [29]. However, the relationship between abdominal obesity and mortality is still inconclusive in epidemiologic studies targeting older adults. A meta-analysis of prospective studies targeting younger-old (between ages 65 and 74) showed that a large WC (men ≥102 cm, women ≥88 cm) was associated with increased all-cause mortality in all weight group when compared with control of healthy weight (BMI 20 to 24.9kg/m^2) with small WC (men <94cm, women <80cm) [30].

According to a report from Asia, in a three-year prospective study targeting older people over 80 years old in China, the overweight or obese participants (BMI >24.0 kg/m^2) had lower the risk of death, as well as the abdominal obesity group (men WC≥86, women ≥83 cm) [31]. According to an analysis of a Korean cohort study (30 to 90 years), the relationship between WC and mortality risk adjusted by BMI shows that mortality risk increases as WC increases, even in participants aged 60 and older. However, the risk was lower compared with those <60 years [32].

The meta-analysis of three Japanese observational studies (aged 40 and older) showed that the highest quintile of WC (90.0 to 112.0 cm) had a significant reduction of all-cause mortality risk compared with the lowest quintile WC (58.0 to 75.8 cm) in only older men (≥65 years). Contrarily, WC was not associated with all-cause or CVD mortality risk in mid-aged and older women [33].

In conclusion, prospective studies are still controversial regarding the impact of abdominal obesity on life prognosis in the older adults. Even if abdominal obesity is a risk of death in older adults, its effect is milder than in middle-aged adults. In addition, the relationship between WC and the risk of death may differ between younger-old and older-old, and the relationship between WC and mortality may change from positive to negative with age among older people (Table 3).

ii) Difficulties in physical functioning

Generally, abdominal obesity is associated with excess burden of ill health and physical disability in middle-aged adults [34]. In a cross-sectional study for people over 90 years in Finland, the highest WC tertile (women WC ≥92, men WC ≥100 cm) in women was more likely to have lower physical performance and ADL disability compared to the lowest WC tertile, but the same was not observed in men [35]. Moreover, there are reports of the opposite relationship in sex [36]. In another cross-sectional study of 870 older Chinese adults aged 90 years and older, participants in the highest WC quartile group (men WC ≥83.0, women WC ≥82.0 cm) showed significantly increased association with either ADL or instrumental ADL (IADL) disability, compared with those in the lowest WC quartile group [37]. Thus, there seems to be a cross-sectional relationship between abdominal obesity and ADL disability in older adults, but the results are not necessarily consistent.

The numerous prospective studies suggest that the abdominal obesity in the older adults is a risk of physical functional decline and ADL disability. A population-based cohort study conducted in Switzerland of younger-olds (aged 65 to 70) demonstrated that ADL disability tended to increase monotonically across WC quintiles [38]. In the international longitudinal observational study of younger-olds aged 64-74 years, participants with abdominal obesity (women WC≥ 88, men ≥102 cm) had higher mobility disability in 4 years, as well as increased risk of ADL disability, compared with control [39].

In contrast, a prospective cohort study targeting oldest-olds (≥90 years) showed that neither low nor high WC at enrolment was associated with incident mobility disability. However, only in women, the lowest WC tertile (<82 cm) was associated with an increased probability of incident ADL disability when compared to the middle WC tertile (82 to 89 cm). However, WC was not associated with incident ADL disability in men [40].

These results suggest that abdominal obesity is a risk for ADL disability, at least in younger-olds, but data are limited regarding older-olds or oldest-olds. Hence, further studies will be required (Table 3).

c) Obesity or abdominal obesity associated with muscle loss or weakness

i) Mortality

Since the report of Baumgartner et al. [41], many papers have been published investigating the effect of obesity associated with sarcopenia (loss of skeletal muscle mass associated with muscle weakness or performance) or dynapenia (the loss of muscle strength) on the adverse outcomes in older adults, although there is currently no definitive diagnostic criteria. The recent meta-analysis indicated that sarcopenic obesity was significantly associated with a higher risk of all-cause mortality compared with non-sarcopenic non-obese [42].

ii) Difficulties in physical functioning

Baumgartner et al. reported that the participants with sarcopenic obesity was associated with IADL and ADL disability [41]. The prospective study found that sarcopenic obesity is a significant risk factor for incident IADL disability, compared with those without sarcopenic obesity at baseline [43]. Another prospective cohort study of men aged ≥70 years demonstrated that sarcopenic obesity had an increased risk of frailty, ADL and IADL disabilities, compared with the group with a healthy body composition [44].

The 9-year prospective study of older people aged 65-95 years (In CHIANTI study) showed that participants with dynapenic nonabdominal obesity and nondynapenic abdominal obesity had no significant risk of ADL disability, but the combination of dynapenic abdominal obesity had more than a twofold increase in the risk of worsening ADL disability compared with nondynapenic nonabdominal obesity [45]. In the English Longitudinal Study of Ageing, the estimated change over time in ADL disability was significantly higher for participants with dynapenic abdominal obesity than for those with neither condition. Furthermore, participants with only dynapenia and abdominal obesity had trajectories in ADL disability that were similar to participants with neither condition [46].

From these results, it can be concluded that sarcopenic or dynapenic obesity (especially when evaluated as abdominal obesity) in older adults is a strong risk of mortality and ADL disability (Table 3).

d) Weight change and poor health outcomes

i) Mortality

The meta-analysis of 15 studies (mean age range from 42.2 to 75.3 years) demonstrated that unintentional weight loss was associated with significant risk of death from any cause compared with weight stable [47)]. This risk was even greater among older participants (Table 4). The observation study from the US, which examined the effect of weight change in adults to older adults (45 to 75 years) on life prognosis demonstrated that, those who lost weight (>2.5 kg) and those with the highest weight gain (>10 kg) were at increased risk of all-cause mortality [48)]. Although increase in risk with weight loss was similar across the age groups, the risk of death due to weight loss is significantly increased even in obese persons, but the HR is higher in subjects with lower BMI [48)].

In another meta-analysis of 17 prospective studies targeting older adults, weight loss (at least by 5% or -1 BMI unit per year) and weight gain (at least by 5% or +1 BMI unit per year) increased mortality risk compared with those in the maintenance group [49)]. Additionally, higher risk was observed in participants with weight loss than in those with weight gain. The impact of this weight loss on mortality risk is consistent in both Western and Asian reports, regardless of gender or observation period [49)].

On the contrary, regarding the relationship between intentional weight loss and mortality risk, a meta-analysis of studies on overweight and obese adults showed that an intentional weight loss had a small benefit for individuals classified as unhealthy obese, but appeared to be associated with slightly increased mortality for healthy individuals [50]. Recent meta-analysis of 15 randomized controlled trials (mean age: 52 years; mean BMI ranged from 30 to 46 kg/m^2; mean follow-up periods: 27 months; average weight loss: 5.5±4.0 kg) demonstrated that the weight loss groups experienced a 15% lower all-cause mortality risk [51]. The effect of intentional weight loss for overweight or obese older adults on the mortality remains inconclusive due to the limited number of studies. However, some studies reveal that intentional weight loss does not increase the mortality risk and may be beneficial for overweight or obese older adults [52,53] (Table 4).

Regarding longer-term weight trajectories and mortality risk, there are reports from the US and Japan that investigated the relationship between BMI change patterns and mortality by observing later middle-aged adults for 13-16 years. Both reports observed that overweight stable trajectory had the highest survival rate.

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ii) Difficulties in physical functioning

Weight loss is a diagnostic factor for frailty (phenotype model), and the relation between weight loss and physical function decline is widely known. In fact, unintentional weight loss has been reported to reduce ADL, decrease life space, and even increase the risk of falls [54-56]. In a 2-year cohort study of community dwelling Japanese older adults with physical or mental disability in some degree, BMI at enrollment was not a significant predictor of further ADL decline, but the decline in

BMI level and the loss of ADL function were associated with each other during the study period [54]. The prospective cohort study of community-dwelling older adults (≥65 years) for 4 years demonstrated that those with a history of unintentional weight loss (>4.5 kg) predicted more rapid ADL and life space declines, although BMI levels at enrollment did not predict those declines [55]. Contrarily, those with intentional weight loss had no relation with ADL function and life space declines [55] (Table 4).

Intervention study targeting older obese adults revealed that weight management (diet) and exercise intervention provides greater improvement of physical function compared with weight management only or exercise only [57]. The adverse effects, reduction in lean body mass, and bone mineral density were observed in the diet-only intervention group, suggesting that diet-induced weight reduction associated with exercise to maintain the lean body mass and bone mineral density is important to improve physical function for older obese adults.

Other important nutrition-related matters for older adults

a) Frailty, sarcopenia

The presence of frailty (phenotype model) and sarcopenia is an important condition for extending the healthy life expectancy of the older people. The meta-analysis using the Mini Nutritional Assessment (MNA®), (a tool used for grading the nutritional status of older persons) in community-dwelling older adults demonstrated the pooled prevalence of physical frailty of three categories of nutritional status: malnutrition (68.0%), at risk of malnutrition (42.9%), and normal nutritional status (11.9%) [58]. This suggests that malnutrition and physical frailty often coincide in community-dwelling older adults. Contrarily, cross-sectional analyses suggest a U-shape association between BMI and frailty, that is, low and high BMI are associated with high prevalence of frailty with lowest prevalence between 25 and 29.9 kg/m^2 BMI [59,60]. The discrepancy of the relationship between frailty and nutritional status evaluated with MNA® and BMI seems to be because MNA® cannot extract the overnutrition status of older adults.

Prospective studies found that overweight or obesity in midlife is a risk factor for physical frailty in later life [61]. Few studies have focused on BMI levels in old age as a risk for developing physical frailty. However, a study using percentage fat mass as an index of obesity reported that obesity in the old adults alone is not a risk for developing frailty [44]. It is therefore evident that weight loss in old age, a diagnostic factor for physical frailty, is a risk of developing frailty (Table 2 and 4).

Lower BMI is a risk factor for not only prevalence but also incidence of sarcopenia [62,63]. In the Newcastle 85+ Study (mean age 85.5 years), participants with normal or raised BMI were at reduced risk of prevalence of sarcopenia and incidence of sarcopenia compared with lower BMI (<18.5 kg/m^2) [63]. These results may suggest that higher BMI is protective of incident sarcopenia in older old. Prospective studies found that changes in body weight in the later life, whether increase or decrease, pose a risk of a decrease in lean mass [64,65] (Table 2 and 4). Furthermore, an improvement of nutritional status and supplementation of protein and amino acid are effective for treatment of sarcopenia and frailty, along with exercise [66,67].

b) Metabolic syndrome (MS)

The prevalence of MS increases with aging, and it is generally reported that the prevalence is higher in older adults than in adults [68]. Presence of MS is already established as a risk factor associated with all-cause and CVD deaths in middle-aged adults [69]. Meta-analysis found that the presence of MS in older people (≥60 years) is also a risk for all-cause and CVD deaths, but at a lower risk than in middle-aged adults [70].

However, there are some reports that the presence of MS is not a risk for all-cause mortality or CVD death in older adults [71,72]. MS and its components are associated with type 2 diabetes but have weak or no association with the incident CVD risk in older populations [73]. One large cohort study, the Rotterdam study, demonstrated that MS does not have additional value in the risk evaluation of type 2 diabetes, CVD, and mortality in older adults [74]. In addition, the prospective study revealed that MS of older adults was the significant risk for developing limitations in mobility, IADL, but not for ADL[75].

In conclusion, the impact of MS on the life prognosis in the older adults is clearly reduced compared to middle-aged adults (Table 3). However, the age of the older adults, for example younger-old and older-old, may differ in their impact on this risk.

Diet intervention for lifestyle-related diseases and risk of frailty in older patients

According to various clinical guidelines, dietary intervention is recommended for various lifestyle-related diseases. For example, for patients with diabetes or dyslipidemia, it is recommended to restrict energy intake or animal fat intake. Low salt intake is recommended for patients with hypertension, chronic heart failure, and chronic kidney disease (CKD). Restriction of protein intake is recommended for CKD patients to delay the transition to end-stage renal failure. However, these effective dietary interventions for lifestyle-related diseases in middle-aged adults may cause various health disorders in the older patients, increasing the risk of frailty (Figure 2).

Transition of nutritional management - shift of MS to frailty

Figure 3 shows the conceptual figure proposing the timing of the gear change from MS to frailty. The target of the concept of MS (overnutrition measures) is an adult under the age of 65, and the target of the concept of frailty (undernutrition measures) is 75 years of age or older. Among them, the older people aged 65-74 (younger-old) are designated as gray zones for individual support. This age group still has some subjects who should focus on MS, while others should shift to nutrition management for frailty earlier. So how do we provide nutritional guidance to this younger-old? How do we decide for individual subjects whether to provide guidance for MS or frailty? Weight variation will be a good indicator. If unconscious weight loss has already begun, they should be shifted to frailty intervention early. Subjects who are still obese or who are gaining more weight should still be responding to MS.

Conclusion

Various health disorders (risk of mortality and physical impairment) increase in obese persons whose BMI exceeds 30 kg/m^2, even in the older adults. Although low BMI poses a high risk of ADL disability and death in older adults, the risk in the overweight older adults (BMI 25 to <30kg/m^2) is lower than in middle-aged adults. Overweight may be more beneficial than lower level of normal weight (BMI 18.5 to <24 kg/m^2) in the older-old and vulnerable older people who are hospitalized or living in nursing homes. Thus, the optimal BMI of the older adults is not only determined by age alone, but also by comorbidities, physical function, and cognitive function status. It is unclear why older adults have higher optimal BMIs than middle-aged adults do; as mentioned earlier, shortened height and consequent increase in BMI may be a factor, but this seems not to be the only reason, and cannot explain the reduction of abdominal obesity risk for poor health outcomes in older-old.

With regard to abdominal obesity, the risk of death and disability increases even in older adults. Given that these risks decrease in older-old, the adverse effects of abdominal obesity may be limited to the younger-old. In fragile older-olds, abdominal fat, which leads to poor health outcomes such as MS in middle-aged adults, may serve as some physiological protective reserve in severe infections and diseases. Unintentional weight loss is clearly a strong risk of mortality and physical dysfunction even in older obese adults.

In conclusion, the optimal BMI of older adults is relatively wide, from normal to overweight (BMI 24.0 to <30 kg/m^2), and to reduce the risk of death and physical function decline, it is important to maintain the optimal BMI and further prevent weight loss to extend healthy life expectancy. Abdominal obesity is also a risk of these poor health outcomes, at least up to the younger-old.

Disclosure

The author has no potential conflicts of interest to declare regarding this manuscript.

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Figure 1. Energy and macronutrient intake by age group from 50 to ≥80 years

Data were from 2018 Japanese National Health and Nutrition Survey. Data show mean ±SD (energy intake) or mean (intake and % of total energy).

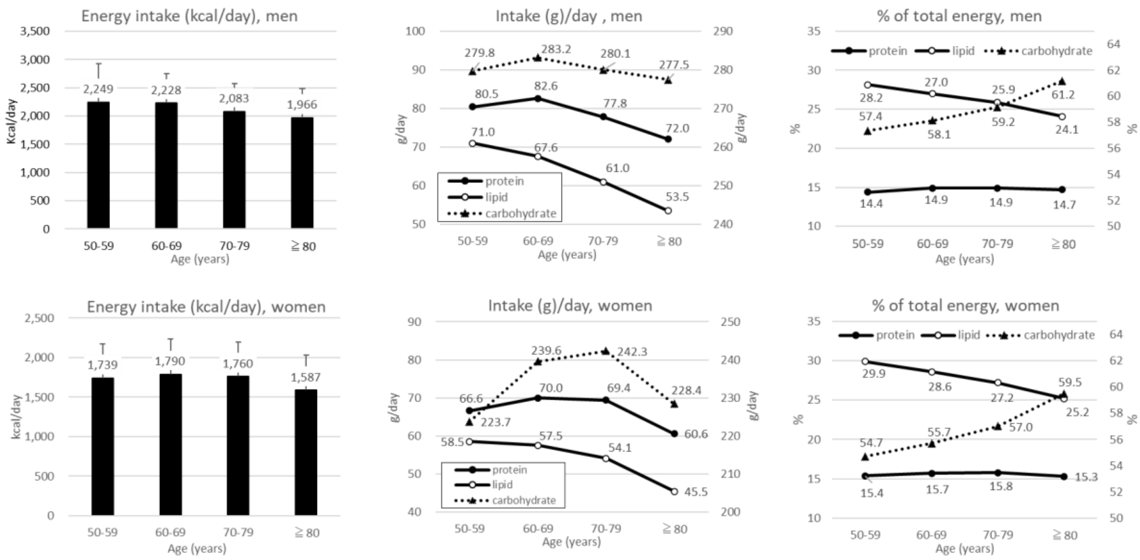

Figure 2. Diet intervention for lifestyle-related diseases and risk of frailty in older patients

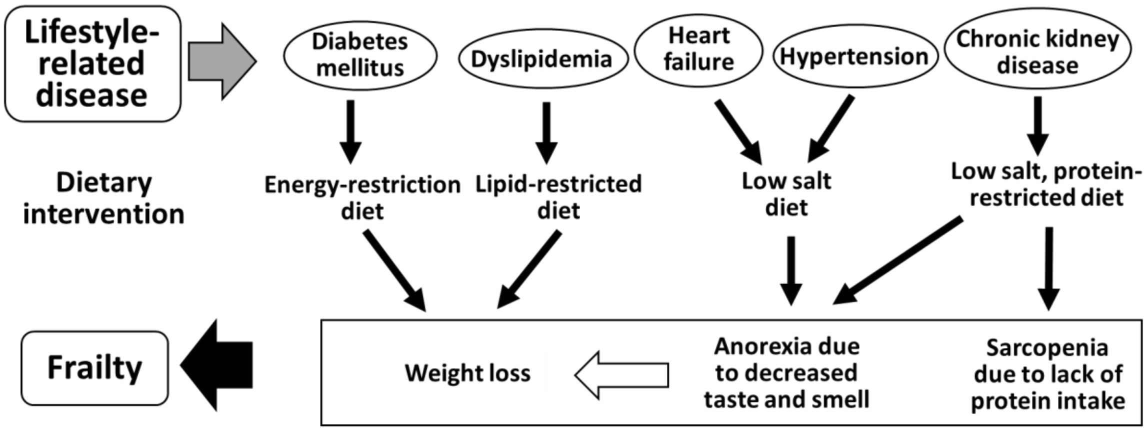

Figure 3. Timing of the gear change from metabolic syndrome to frailty.