MALNUTRITION

A Hidden Cost in Health Care
This manual was developed for health care decision-makers and is presented as a service of Ross Products Division, Abbott Laboratories.

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### Glossary of Acronyms and Abbreviations

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<th>ADLs</th>
<th>Activities of Daily Living</th>
<th>DBP</th>
<th>Diastolic Blood Pressure</th>
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<td>ALB</td>
<td>(serum) Albumin</td>
<td>EDP</td>
<td>(food) Exchange Diet Plan</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
<td>FPG</td>
<td>Fasting Plasma</td>
</tr>
<tr>
<td>CHOL</td>
<td>Cholesterol</td>
<td>HG</td>
<td>Hand Grip</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
<td>IDP</td>
<td>Individualized Diet Plan</td>
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<tr>
<td>CVD</td>
<td>Cardiovascular Disease</td>
<td>LDL</td>
<td>Low-Density Lipoprotein</td>
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<td></td>
<td></td>
<td>LED</td>
<td>Low-Energy Diet</td>
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<td></td>
<td></td>
<td>LOS</td>
<td>Length of Stay</td>
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<td></td>
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<td>MDS</td>
<td>Minimum Data Set</td>
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<td></td>
<td></td>
<td>MNA</td>
<td>Mini Nutritional Assessment</td>
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<td></td>
<td></td>
<td>MR</td>
<td>Meal Replacement</td>
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MALNUTRITION: A HIDDEN COST IN HEALTH CARE

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MST Malnutrition Screening Tool
MUST Malnutrition Universal Screening Tool
NRI Nutritional Risk Index
PAB (serum) Prealbumin
PEM Protein-Energy Malnutrition
PNI Prognostic Nutritional Index
QOL Quality of Life
RR Relative Risk
SBP Systolic Blood Pressure
SGA Subjective Global Assessment
TD Traditional (reduced-fat and =calorie) Diet
TG Triglyceride
VLED Very-Low-Energy Diet
WC Waist Circumference
YLL Years of Life Lost
Common Measures of Protein-Energy Malnutrition
Malnutrition (undernutrition) in health care settings in the United States usually occurs as some form of protein-energy malnutrition (PEM). Primary PEM results from an acute or chronic deficiency of both protein and calories. Secondary PEM results from a disease or medical condition such as cancer or gastrointestinal disease that alters requirements for or impairs utilization of nutrients.

Definitions of PEM and techniques for identifying the condition in patient populations vary greatly among researchers. Below are some of the parameters and threshold values used to define and identify PEM in the research reports included in this document.

### Anthropometric and Laboratory Values
- **Body mass index (BMI, wt kg/ht m²):**
  - >19 to <22, at risk; <19, malnourished
- **Unintentional weight loss:** >10% of body weight in last 6 months or >5% in last 3 months
- **Weight for height ratio:** <90% of ideal
- **Serum albumin (ALB):** <3.5 g/dL (or <35 g/L)
- **Prealbumin (PAB, or transthyretin):** <20 mg/dL (values <16 mg/dL more typically used)
- **Retinol-binding protein (RBP):** <3 ng/mL

### Screening and Assessment Tools*
- **Malnutrition Screening Tool (MST):** ≥2, at risk
- **DETERMINE Screening Tool:** 3 to 5, moderate risk; ≥6, high risk
- **Malnutrition Universal Screening Tool (MUST):** 1, medium risk; ≥2, high risk
- **Subjective Global Assessment (SGA):**
  - SGA-B, moderately or suspected malnourished;
  - SGA-C, severely malnourished
- **Mini Nutritional Assessment (MNA):**
  - 17 to 23.5, at risk; <17, malnourished
- **Nutritional Risk Index (NRI):** 83.5 to <100, malnourished; <83.5, severely malnourished
- **Prognostic Nutritional Index (PNI):** ≥40, malnourished

*These tools are described on pp 23–25.
INTRODUCTION: REDUCING THE COSTS OF MALNUTRITION

INTRODUCTION

The Hidden Costs of Malnutrition

Reducing the Costs of Malnutrition
Through Nutrition Support
The Hidden Costs of Malnutrition

Malnutrition is a cause of disease and death worldwide, as evidenced in famines in Niger, Sudan, and other developing regions. Indisputably, appropriate nutrition interventions in these tragic human events could save lives and prevent substantial morbidity.

In developed nations, where famine is not a problem, malnutrition (undernutrition) is not a routine concern, and nutrition screening and assessment are not uniformly a part of medical care. Thus, malnutrition is not always recognized in the clinical setting.

Nevertheless, research consistently shows that malnutrition—a state of inadequate or unbalanced nutrition—is a hidden cause of poor health outcomes and rising health care costs in the United States and other developed nations.

The hidden costs of malnutrition in the US health care system were brought to light in Butterworth’s classic 1974 article “The skeleton in the hospital closet” (Nutr Today, vol 9). More than 30 years later, hundreds of studies involving thousands of patients and epidemiologic studies involving millions of patients reveal three major findings:

- Malnutrition and risk for malnutrition are still highly prevalent in some patient populations.
- Malnutrition is still associated with increased morbidity and mortality, decreased quality of life, longer length of (hospital) stay (LOS), and increased health care costs.
- The economic and human costs of malnutrition are avoidable.

Malnutrition is particularly common among hospitalized patients and older adults. Among hospitalized patients, for instance, as many as half are estimated to be malnourished or at risk for malnutrition. Prevalence of malnutrition is especially high among patients with such diseases as chronic obstructive pulmonary disease (COPD), cancer, stage 4–5 chronic kidney disease, congestive heart failure, gastrointestinal disease, and HIV/AIDS.
Reducing the Costs of Malnutrition Through Nutrition Support

Health care decision-makers today are challenged to provide effective care, yet control the cost of delivering such care. Health care providers are concerned with expenses, LOS, and complication rates. Payers are interested in hospitalization rates, LOS, and general care costs.

While strategies to limit the cost of medications and shorten hospital stays are widely discussed as ways to save money, the human and financial costs that result from malnutrition are all too often overlooked.

Yet many studies show that routine nutrition screening, assessment, and intervention are key components of good health care: They are cost-effective measures that may improve outcomes and reduce health care costs.

Health care decision-makers can help reduce care costs by following these steps:

- Screen patients for risk of malnutrition using a quick, inexpensive nutrition screening tool. Some tools are even self-administered.
- Assess those identified as at risk for malnutrition to determine the presence and severity of the condition.
- Intervene with nutrition support for those determined to be malnourished or at risk for malnutrition.

By following these steps, clinicians are able to provide nutrition intervention only to patients who need it and can benefit from it.

A number of validated nutrition screening and assessment tools are available that can be incorporated into routine clinical practice, depending on the expertise of the personnel. Some of the more commonly used are described on pp 23–25 of this document.

This document, although not exhaustive, describes the extent of malnutrition among at-risk populations in the United States and presents scientific and economic justification for routine nutrition screening and appropriate assessment and intervention.

After reading this document, the health care decision-maker will be able to

- Describe the prevalence of malnutrition—both undernutrition and overnutrition—among at-risk populations in the United States.
- Describe the effects of malnutrition on morbidity, mortality, quality of life (QOL), LOS, and total health care costs.
- Outline the major methods of screening for and assessing malnutrition.
- Suggest cost-saving nutrition interventions for both undernutrition and overnutrition that can be implemented in most health care settings.
Prevalence of Malnutrition/Undernutrition

Hospital Patients

Sub-Acute Care Patients

Long-Term Care Residents

Community-Dwelling Older Adults

Medical Outpatients

Dialysis Patients

References
Reports of the prevalence of malnutrition/undernutrition in the United States vary greatly depending on a number of factors, including patients' diagnoses and age, the setting, and the nutrition parameters and assessment tools used. Thus, in the studies summarized below, the prevalence of malnutrition and elevated malnutrition risk in various patient groups ranges from 11% to 91%. The prevalence is particularly high among older adults.

**Hospital Patients**

- A total of 320 patients from four hospital units were administered a standard nutrition-screening protocol, and blood was drawn to test prealbumin (PAB) and retinol-binding protein (RBP) values. Based on the results of the standard screening, 33% of the patients were deemed to be malnourished. According to PAB and RBP results, however, 51% and 54%, respectively, were classified as malnourished.1
- A cohort of 213 adults hospitalized with pneumonia was followed prospectively and short-term outcomes documented. Malnutrition was identified in 15% of patients, based on serum albumin (ALB) <2.9 mg/dL or unintentional weight loss >4 kg in the preceding 3 months.2
- A total of 173 patients admitted to any of three inpatient medical units over a 1-month period were enrolled in a prospective study of the impact of nutritional status on outcomes. Patients were classified as being at nutritional risk based on one or more of the following criteria: weight for height <75% of ideal body weight, ALB <3.0 g/dL, ≥10% unintentional weight loss during the month before admission. Based on these criteria, 32% of patients were identified as malnourished or at risk for malnutrition on admission.3
- Patients admitted to a general intensive care unit over a 4-month period were included in a prospective study of the outcomes of nutritional status. The patients' nutritional status was determined on admission using ALB and a weight/height ratio—<3.5 g/dL and <100%, respectively, indicating malnutrition. Of the 129 patients who participated, 43% were malnourished.4
- Fifty-one patients with end-stage emphysema who were undergoing lung volume reduction surgery participated in a study of nutritional status and surgery outcomes. Body mass index (BMI) values were below normal in 53% of the patients.5
- Over a period of 7 months, 404 adult hospital inpatients were enrolled in a prospective study that examined the association between in-hospital changes in nutritional status and outcomes. Nutritional status of patients was determined within 72 hours of admission using the Subjective Global Assessment (SGA) tool and again at discharge. The prevalence of malnutrition (SGA scores B and C, moderately and severely malnourished) was 54% at admission and 59% at discharge. The nutritional status of 31% of patients declined over the course of their hospitalization.6
- Sixty-seven hospitalized gynecologic oncology patients were evaluated for nutritional status using the Prognostic Nutritional Index (PNI) method (using serum albumin, transferrin, triceps skin fold, skin sensitivity tests). The prevalence of malnutrition was found to be 54% in this population.7
- A total of 369 older adult patients (≥70 years of age) admitted to a general hospital service were assessed by SGA. Nearly 41% of the cohort was determined to be moderately or severely malnourished on admission.8
Sub-Acute Care Patients

- Nutritional status was evaluated for 489 older adult patients (mean age 76 ± 13 years) admitted to a sub-acute center using ALB and BMI. A subgroup of 104 patients were administered the Mini Nutritional Assessment (MNA). Low ALB was found in 67% of patients. A BMI <19 was reported for 17% of patients and <22 for 33%. More than 91% of the patients assessed by the MNA, however, were either malnourished or at risk for malnutrition.9

<table>
<thead>
<tr>
<th>MNA score</th>
<th>No. of subjects n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malnourished (&lt;17)</td>
<td>30 (28.8)</td>
</tr>
<tr>
<td>At risk (17–23.5)</td>
<td>65 (62.5)</td>
</tr>
<tr>
<td>Well nourished (&gt;23.5)</td>
<td>9 (8.7)</td>
</tr>
</tbody>
</table>

Long-Term Care Residents

- A sample of 311 long-term care (LTC) residents (≥65 years of age) was recruited from three LTC facilities. Using data from the Minimum Data Set (MDS), researchers found that nearly 40% (38.6%) of the residents had a BMI <22, and thus met the BMI criterion for malnutrition risk.10

- Citing a decade of research, authors of a report on malnutrition and dehydration in LTC facilities indicate that from 35% to 85% of US LTC residents are malnourished and 30% to 50% are substandard in body weight.11

Medical Outpatients

- Charts of 1017 patients attending a hospital outpatient department were screened for at least one of three markers of malnutrition: body weight <90% of appropriate median weight using age, gender, and height-adjusted norms; documented weight loss of >5 pounds in the preceding 6 months; and/or ALB <3.5 g/dL. Using these criteria, 11% of older patients (≥65 years) and 7% of younger patients (18–64 years) were identified as undernourished.13

Dialysis Patients

- A structured survey questionnaire was sent to renal dietitians in 196 outpatient hemodialysis (HD) and 86 peritoneal dialysis (PD) programs in Texas to determine the prevalence of malnutrition among their patients with end-stage renal disease. Based on ALB values, weight loss, and a variety of other measures, the prevalence of malnutrition was 17% among HD patients and 31% among PD patients.14

- A retrospective longitudinal review of medical charts of 442 patients receiving hemodialysis indicated that 51% were at moderate nutritional risk, and 19% were at high risk.15

Community-Dwelling Older Adults

- A review of 11 studies from the United States and Europe of older adults living in community settings found that ≤2% were actually malnourished. Between 15% and 44%, however, were at risk of malnutrition due to inadequate nutritional intake.12
References


Economic and Human Costs of Malnutrition

- Increased Morbidity
- Increased Mortality
- Decreased Quality of Life and Functioning
- Increased Hospital Stays and Admissions
- Higher Health Care Costs

References
One meta-analysis of 90 cohort studies showed that low ALB was a strong independent predictor of poor outcomes. For each 10-g/L decline in ALB, the odds of mortality increased by 137%, of morbidity by 89%, of prolonged ICU stay by 28%, of prolonged LOS by 17%, and of increased resource utilization by 66%.\textsuperscript{1}

A multitude of studies from the United States and other countries, including those summarized below, have verified that malnourished patients are at increased risk for morbidity and mortality. Furthermore, malnutrition reduces QOL, especially in frail older adults, in whom it can have devastating effects on functioning. Because malnourished patients experience more complications than well-nourished patients, their care costs are higher and inpatient LOS is longer. Thus, total costs of care are significantly higher for malnourished patients.

Malnutrition Is Associated With Increased Morbidity

- Over a 3-year period, 586 older adult patients (mean age 74 years) who were hospitalized for at least 3 days were enrolled in a study of the impact of malnutrition on outcomes. Seven parameters of malnutrition were used (see figure below). Those patients determined to be malnourished had 3 to 7 times the risk of life-threatening complications while hospitalized (relative risk for those with a BMI <22 and a suprailiac skinfold thickness in lowest tertile of study population, respectively).\textsuperscript{2}

![Nutrition Variable Graph]

* The high- and low-risk tertile cutoffs for each parameter were as follows: BMI high risk <22, low risk ≥22; pre-albumin high risk <18 mg/dL, low risk ≥18 mg/dL; serum cholesterol high risk <160 mg/dL, low risk ≥160 mg/dL; serum albumin high risk <30 g/L, low risk ≥30 g/L; weight loss of 5% in previous 6 months, high risk = yes, low risk = no; suprailiac skinfold high risk <14 mm, low risk >14 mm; mid-arm circumference high risk <286 mm, low risk >323 mm.
Among 5,031 non-cardiac surgical patients at a Veterans Administration hospital, those with malnutrition (as indicated by significant weight loss before surgery) had significantly increased risk for infection of the surgical incision compared to those who were adequately nourished. At admission, 155 patients hospitalized for internal and GI diseases were assessed for nutritional status; 45% were malnourished according to the SGA and 57% according to the Nutritional Risk Index (NRI). A significantly higher number of complications was seen in malnourished patients than in well-nourished patients. The figure below shows the mean number of complications malnourished (solid bar) and well-nourished (hatched bar) patients experienced in the hospital according to each method of nutrition assessment used. The association between severity of malnutrition and occurrence of complications remained even after adjustment for confounding factors.

Patients with protein-energy malnutrition (PEM) have reduced immune function. This is because PEM results in the lowering of antibody and cell-mediated responses; decreased circulating immunoglobulins, macrophage function, and tissue repair; and increased oxidative stress.

During a 4-month prospective study, 129 patients admitted to an ICU were divided into well-nourished and malnourished groups based on ALB and weight/height ratio and followed clinically until discharge or death. Length of stay (LOS) ($P = ns$), incidence of complications ($P < 0.01$), and number of patients not discharged from the hospital ($P < 0.05$) were greater among malnourished patients than among the well-nourished.

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Researchers used data from the US Renal Data System for 8,920 patients with end-stage kidney disease to assess risk factors for stroke. Markers of malnutrition were strongly associated with increased risk. Patients who were subjectively described by staff as undernourished had an estimated 27% increased risk for stroke, for instance, and a 1-g/dL decrement in ALB was associated with a 43% increased risk for stroke.5

Fifty outpatients diagnosed with cirrhosis of the liver were assessed for nutritional status using SGA, PNI, and hand grip (HG) strength. Based on HG, 63% were malnourished. Nearly 66% of those patients experienced major complications compared to 11.8% of the well-nourished patients (P < 0.05).8

Researchers reviewed the medical records of 265 LTC residents to examine which clinical indicators were associated with the presence of pressure ulcers. The indicator present most often was an ALB level <3.5 g/dL with a normal hydration status.9

Thirty-seven patients on long-term hemodialysis were studied for a mean period of 26 months. Researchers found that all-cause morbidity as defined by the number of hospitalizations significantly correlated with composite PEM scores (P < 0.05). Infection-related morbidity was associated most strongly with the PEM score, suggesting that PEM may contribute to morbidity because of its effect on the immune system and infection.10

The nutritional status of 201 patients who had experienced acute stroke was determined by several nutrition measures at hospital admission. Those patients with low concentrations of ALB (<3.5 g/dL) were significantly more likely to experience infective complications (P < 0.0001) than those with normal concentrations. Furthermore, lower concentrations were a strong, independent predictor of 3-month mortality.11

Malnutrition Is Associated With Increased Mortality

A total of 497 hospitalized patients >65 years of age with a LOS of at least 4 days were enrolled in a prospective study to determine whether in-hospital nutrient intakes correlated with mortality risk. Of the total cohort, 21% had an average daily intake <50% of their calculated maintenance energy requirement. At discharge, those patients had significantly lower ALB and PAB concentrations and higher rates of in-hospital and 90-day mortality (see table below).12

### Clinical Outcomes

<table>
<thead>
<tr>
<th>Clinical Outcomes</th>
<th>Low Nutrient Intake* (n = 102)</th>
<th>All Others (n = 395)</th>
<th>Adjusted Relative Risk (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharged home‡</td>
<td>78 (76.5)</td>
<td>337 (85.3)</td>
<td>0.6 (0.3–1.3)</td>
</tr>
<tr>
<td>Functionally dependent at discharge§</td>
<td>28 (27.5)</td>
<td>63 (16.0)</td>
<td>2.3 (1.1–4.6)</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>12 (11.8)</td>
<td>6 (1.5)</td>
<td>8.0 (2.8–22.6)</td>
</tr>
<tr>
<td>Death within 90 days of admission</td>
<td>16 (15.7)</td>
<td>23 (5.8)</td>
<td>2.9 (1.4–6.1)</td>
</tr>
</tbody>
</table>

* Subjects whose average daily nutrient intake while hospitalized was <50% of calculated maintenance requirements.
† Adjusted relative risk based on logistic regression controlling for admission albumin level, functional status, total APACHE score, calculated diagnosis related group LOS, the Charlson Weighted Index of co-morbidity, whether residing in a nursing home at the time of admission. Other than mortality, also controlled for LOS. CI = confidence interval
‡ Discharged directly home as opposed to a nursing home or rehabilitation center
§ Completely dependent in 1 or more activities of daily living using the Katz Index of Activity of Daily Living Scale
• Researchers enrolled 214 community-dwelling older adults in a prospective study to determine whether a BMI <22 predicted mortality. Compared to adequately nourished patients, those with malnutrition (33%) were significantly more likely to have pressure ulcers (P = .02) and reduced functional ability (P = .03). At the end of the 1-year follow-up, a low BMI was found to be a significant and independent predictor of shortened survival, even when controlling for clinical and functional variables.13

• The nutritional status of 88 patients in an acute geriatric inpatient ward was evaluated using SGA and MNA. Based on SGA, 20% were malnourished; based on MNA, 26% were malnourished. Mortality was higher in those identified as malnourished, 50% after 1 year and 80% after 3 years, than in those identified as well-nourished, 20% after 1 year and 40% after 3 years (P <0.01 for 3-year mortality).14

• In a retrospective cohort study of 709 hospitalized adults, mortality was 12.4% among malnourished patients (as assessed by SGA) and 4.7% among the well-nourished (relative risk, 2.63). Using multivariate analysis, researchers determined that malnutrition was an independent risk factor for mortality.15

• In a prospective study of 55 patients with amyotrophic lateral sclerosis (ALS), those determined to be malnourished using BMI had a 7.7-fold increased risk of death compared to those with a higher BMI. Multivariate analysis indicated that malnutrition was a significant independent risk factor for survival (P <0.01).16

• Researchers followed 10,317 patients aged 18 years and older who had either cancer or cardiovascular disease to determine whether nutritional status as indicated by BMI affected rates of health care usage and mortality. In both diagnostic groups, patients with a low BMI (<20) had higher rates of consultation with a general practitioner, higher rates of medication use, and higher death rates during follow-up than those with a BMI of 20–<25. The figure below shows the standardized mortality rates (SMR) in the sub-group of patients aged 65 years and older according to BMI categories and diagnostic group.17

• In a prospective study of 7719 adult hemodialysis patients, lower baseline measurements of a modified SGA (mSGA), BMI, ALB, serum creatinine, and lymphocyte count were independently associated with a significantly higher risk of mortality. For instance, patients with “severely malnourished” mSGA scores had a 33% higher mortality risk than those with normal scores, and patients in the lowest BMI quartile had a 60% higher mortality risk than patients in the highest quartile.18

• A total of 322 older adult patients admitted to and discharged from a Veterans Administration hospital were assessed for nutritional risk based on ALB and BMI as well as a number of medical, functional, psychological, and socioeconomic factors. They were followed for 6 years or until they died. The variable most strongly associated with mortality was nutritional risk at discharge (see figure below).19

• Researchers studied the relationship between nutritional status and outcomes in 205 older adult patients hospitalized for conditions other than cancer. Over a 9-month follow-up period, the mortality was 44% among the malnourished patients and 18% among the adequately nourished patients (P < 0.001). Among malnourished patients with congestive heart failure, mortality was 80%.20

• In a retrospective study of data gathered on 5168 patients who underwent cardiac surgery, researchers found that low BMI (<20) and low ALB levels (<2.5 g/dL) were independently associated with increased postoperative complications and mortality (P ≤0.0005). The highest mortality was observed in patients with both low BMI and low ALB (16%).21

• In a retrospective study of 377 hemodialysis patients, adjusted mortality rates were inversely correlated with initial BMI (P < 0.0001), and weight loss was the greatest independent risk factor for mortality in general.22

• A total of 369 hospitalized older adult patients (≥70 years of age) were enrolled in a prospective study of nutritional status and outcomes. SGA was used to determine their nutritional status at admission; patients were followed up at 3 and 12 months after discharge. Moderately and severely malnourished patients were significantly more likely to have died at both time points than well-nourished patients ($P < 0.001$).

• In a 6-month follow-up study of 894 LTC residents at nutritional risk, those who lost weight during that period were nearly twice as likely to die as those who maintained or gained weight (adjusted relative risk, 1.95; 95% confidence interval 1.43–2.66).

Malnutrition Is Associated With Decreased Quality of Life and Functioning

• The impact of PEM on the quality of life (QOL) of LTC residents was investigated using archived data from the MDS for 311 residents ≥65 years living in three LTC facilities. Residents with a BMI <22 were identified as having PEM. Researchers found a significant relationship between low BMI and impaired functional status and between low BMI and decreased psychosocial well-being—two indicators of QOL.

• Researchers used aspects of a highly validated QOL questionnaire from the European Organization for Research and Treatment of Cancer to evaluate the influence of nutrition factors on QOL. They found that at least 50% of QOL function was determined by nutrition-related factors—weight loss and nutrition intake. In combination, other factors such as cancer location, chemotherapy, surgery, and stage of disease contributed the remainder of the effect on QOL.

Malnutrition Is Associated With Increased Hospital Stay and Admissions

• In a study of 98 frail older adults, nearly a third had fallen at least once in the previous 4 months. Several measures of nutrition, health, functionality, and well-being were assessed to determine which were associated with falls. Regression analysis indicated that level of nutritional risk was a significant determinant of falls. Fallers were described as having a higher level of nutritional risk and poorer physical and psychological well-being than non-fallers.

• Ninety-eight older adult LTC residents who were independent in at least two activities of daily living (ADLs) were enrolled in a 2-year longitudinal study to determine the impact of nutritional status on functioning. Low baseline ALB and subscapular skinfold thickness values were associated with deteriorating functional status as indicated by the loss of at least two additional ADLs.

• In a prospective study of 51 patients with end-stage emphysema undergoing lung volume reduction surgery, 53% were designated as having an impaired nutritional status on the basis of a low BMI. Postoperatively, 26% of those patients required prolonged ventilatory support (>24 h), compared to 4% of those patients with a normal BMI ($P = 0.03$). The average LOS of the patients with a low BMI was significantly longer than that of patients in the normal BMI group—15.8 days vs 11.7 days ($P = .045$).

• A cohort of 213 adults hospitalized with pneumonia were followed prospectively and four short-term outcomes documented. Malnutrition, one of the variables examined, correlated significantly with all four outcomes: LOS ($P = 0.003$), discharge to home ($P = 0.001$), death ($P = 0.001$), and readmission ($P = 0.005$).
The nutritional status of 502 adult patients admitted to two hospitals was assessed on admission, primarily by SGA. The LOS of the malnourished patients was 40% longer than that of the well-nourished patients (13.1 ± 8.1 d vs 9.3 ± 6.8 d, P < 0.0001).31

In a prospective study of 67 hospitalized patients with gynecologic cancer, the median LOS for those who were diagnosed as malnourished was significantly longer than for those who were adequately nourished—8 (range of 6–16) and 6 (range of 4–7) days respectively (P = .004). The difference remained after the researchers controlled for age, extent of metastases, and cancer sites.32

In a retrospective cohort study of 709 hospitalized adults, LOS was longer in malnourished patients (16.7 ± 24.5 days, median 9 days) than in well-nourished patients (10.1 ± 11.7 days, median 6 days).16

In a study of the prevalence and outcomes of malnutrition among 837 subacute-care patients, the MNA was used to assess nutritional status in a sub-group of 104 patients. Mean LOS of the malnourished group was 11 days longer than that of the at-risk group (P = 0.007).33

Researchers assessed the nutritional status of 400 patients within 48 hours of hospital admission. Patients identified as malnourished by SGA had a significantly longer mean LOS than normally nourished patients (7.5 ± 5.4 vs 5.0 ± 5.1, P < 0.05) and significantly more non-elective readmissions (20.7% vs 13.2%, P < 0.05).34

Seventy-one cancer patients in a hospital oncology ward were administered a patient-generated SGA. Those who were moderately or severely malnourished had a significantly longer mean LOS than those who were well-nourished (14.0 d, 9.5 d, and 7.0 d, respectively, P < 0.024).35

ALB levels were measured in 144 patients ≥60 years of age admitted to two community hospitals to determine whether low levels (<3.4 g/dL) of this protein were associated with longer LOS. The researchers indicated that “hypoalbuminemia often results from an interaction between malnutrition and various illness.” The mean LOS for patients with a low ALB level was 6.74 ± 4.79 days, while the LOS for patients with a normal level was 3.85 ± 2.55 days (P < 0.01).36

The nutritional status of 850 hospitalized adults was assessed using BMI, anthropometrics, and history of unintentional weight loss. LOS was significantly longer in the malnourished than in the non-malnourished patients—mean number of days, 8.86 ± 9.67 vs 5.72 ± 7.71, P < 0.001.37

A total of 149 patients newly initiated on maintenance hemodialysis were nutritionally assessed and followed for a year. Those patients in the lowest quartile for ALB—the most severely malnourished—had a significantly greater average number of admissions than those in the highest quartile (1.77 ± 1.82 vs 0.72 ± 0.96 admissions, P = 0.002). Furthermore, the LOS of those in the lowest quartile was significantly longer (8.96 ± 9.96 vs 3.83 ± 5.68 days, P = 0.006).38

In a retrospective longitudinal review of medical charts of 442 patients receiving maintenance hemodialysis, those determined to be at high nutritional risk (19% based on laboratory and anthropometric values) had 75% more hospitalizations and spent 195% more days in the hospital than those at low risk.39
Malnutrition Is Associated With Higher Health Care Costs

- As shown in the study above (reference 40), patients whose nutritional status declined during their hospital stay regardless of their nutritional status at admission had significantly more complications and a longer LOS than those in the reference group whose nutritional status was normal at admission and at discharge. Thus, the patients whose nutritional status declined had significantly higher care costs—$45,762 ± 4,021 vs $28,631 ± 1,835.

- In a retrospective cohort study of 709 hospitalized adults, mean daily hospital costs were $228 per malnourished patient compared to $138 per well-nourished patient—a cost difference of 60.5%. When the costs of medications and tests were added, the costs for the malnourished patients rose to 308.9% compared to well-nourished patients.

- In a subgroup of 52 patients on maintenance hemodialysis in the study described in reference 40, researchers found a nonsignificant trend toward higher hospital costs in the patients with the lowest ALB values. Mean hospital charges for those in the lowest quartile for ALB were $31,154 ± $25,673 compared with $24,394 ± $26,077 for those in the highest quartile.

---

**Table:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group N: normal (reference) (n = 115)</th>
<th>Group I: improved (n = 86)</th>
<th>Group M: maintained (n = 77)</th>
<th>Group D: declined (n = 126)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charges ($)</td>
<td>28,631 ± 1,835&lt;sup&gt;a&lt;/sup&gt;</td>
<td>37,005 ± 3,838</td>
<td>39,873 ± 4,023</td>
<td>45,762&lt;sup&gt;b&lt;/sup&gt; ± 4,021</td>
</tr>
<tr>
<td>LOS (d)</td>
<td>14 ± 0.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18&lt;sup&gt;b&lt;/sup&gt; ± 1.4</td>
<td>17 ± 1.5</td>
<td>19&lt;sup&gt;b&lt;/sup&gt; ± 1.3</td>
</tr>
<tr>
<td>Complications (%)</td>
<td>42</td>
<td>58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>62&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Mean ± standard error

<sup>b</sup> Significantly different from reference group, $P = < .05$ (analysis of variance with Tukey adjustment for multiple comparisons)
Patients (n = 173) admitted to any of three inpatient medicine units over a 1-month period were enrolled in a prospective study of the impact of nutritional status on LOS, hospital costs, and discharge status. Those patients determined to be at nutritional risk had a significantly longer LOS and higher hospital costs than those not at risk, and the at-risk patients were significantly less likely to be discharged to home and self-care (see table below).41

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Not at risk (n = 117)</th>
<th>At risk (n = 56)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS (d) Median</td>
<td>4</td>
<td>6</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>25th, 75th percentile</td>
<td>3,7</td>
<td>4,8</td>
<td></td>
</tr>
<tr>
<td>Costs*</td>
<td>$4,563 ± 3,702</td>
<td>$6,196 ± 4,585</td>
<td>P &lt; 0.02</td>
</tr>
<tr>
<td>Discharged home/self-care (%)</td>
<td>66</td>
<td>41</td>
<td>P &lt; 0.05</td>
</tr>
</tbody>
</table>

*Mean ± standard deviation; includes hospital costs only, excludes professional fees
References


Identifying Malnourished Patients and Those at Risk for Malnutrition

Screening Tools

Assessment Tools

References
Not every patient in every health care setting needs nutrition intervention. How do health care providers know which patients are at risk for the increased morbidity and mortality associated with malnutrition so they can target their interventions to those who can benefit from them? A tiered approach is most cost-effective.

- First, use a screening tool to identify which patients are at risk for malnutrition.
- Second, use an assessment tool to identify which of the at-risk patients actually are malnourished.
- Third, develop a nutrition intervention plan for those with confirmed malnutrition.

Numerous nutrition screening and assessment instruments have been validated and are readily available. This section describes just a few of the most commonly used tools.

Screening tools such as the Malnutrition Screening Tool (MST), the DETERMINE Check List, and the Malnutrition Universal Screening Tool (MUST) can quickly flag high-risk patients for further assessment. Thorough assessments can be completed efficiently using tools such as the SGA, and the results can help personnel design appropriate nutrition intervention plans.

Assessment should include a medical history and a physical examination. A physical examination may include BMI and anthropometric measures such as triceps skinfold and mid-arm muscle circumference.\(^1\) BMI, however, can be distorted by edema, ascites, and other fluid imbalances. Biochemical markers of malnutrition such as ALB, PAB, and lymphocyte counts can be used to assess malnutrition, but these can also be affected by factors other than nutrition. Assessment tools such as SGA provide a more complete picture of nutritional status than biochemical or anthropometric markers alone.

### Screening Tools

- **The Malnutrition Screening Tool (MST)** is a simple, quick, valid, and reliable tool for identifying patients at risk of malnutrition. The tool is comprised of two questions related to weight loss and decreased appetite (see box at right).\(^2\) A score of $\geq 2$ means that the patient is at risk for malnutrition and should be further assessed.

<table>
<thead>
<tr>
<th>MST Score (weight loss and appetite scores)</th>
</tr>
</thead>
</table>

### MST

1. **Have you lost weight recently without trying?**
   - No 0
   - Unsure 2
   - If yes, how much weight have you lost?
     - 2–13 lb 1
     - 14–23 lb 2
     - 24–33 lb 3
     - $> 33$ lb 4
     - Unsure 2

2. **Have you been eating poorly because of a decreased appetite?**
   - No 0
   - Yes 1

**MST Score**

- Weight Loss Score

---

\(^1\) BMI, however, can be distorted by edema, ascites, and other fluid imbalances. Biochemical markers of malnutrition such as ALB, PAB, and lymphocyte counts can be used to assess malnutrition, but these can also be affected by factors other than nutrition. Assessment tools such as SGA provide a more complete picture of nutritional status than biochemical or anthropometric markers alone.

\(^2\) A score of $\geq 2$ means that the patient is at risk for malnutrition and should be further assessed.
**Assessment Tools**

- **Subjective Global Assessment (SGA)** is a validated nutrition assessment tool that includes both a medical history and a physical examination. The medical history focuses on changes in weight, dietary intake, gastrointestinal symptoms persisting more than 2 weeks, and functional capacity. Key indicators of malnutrition are weight loss greater than 5% in the last 3 months or greater than 10% in the last 6 months. The physical examination includes an evaluation of subcutaneous fat, muscle wasting, ankle and sacral edema, and ascites. Patients are assigned a nutrition rating of SGA-A, SGA-B, or SCA-C, indicating well-nourished, moderately or suspected malnourished, or severely malnourished. (Some clinicians now use a 7-point scale instead of the original 3-point scale.) The SGA can be completed in about 15 minutes.

- **DETERMINE Check List** has been developed and distributed by the Nutritional Screening Initiative to screen older adults. DETERMINE is an acronym for warning signs of poor nutritional health: Disease, Eating poorly, Tooth loss/mouth pain, Economic hardship, Reduced social contact, Multiple medicines, Involuntary weight loss/gain, Needs assistance in self-care, Elder years above age 80. The tool consists of a one-page checklist and an information page for the person being screened. A score of 3–5 indicates moderate nutrition risk, and a score of ≥6 indicates high risk.

- **The Malnutrition Universal Screening Tool (MUST)** is a tool for screening adult patients. The clinician measures height and weight to determine BMI, determines the percent of unintended weight loss over the last 6 months, and estimates the effect of illness on nutrition intake. Then he or she combines these scores to derive an overall malnutrition score. A score of 1 indicates medium risk, and a score ≥2 indicates high risk. Based on that score, the clinician develops a patient care plan.

**A Patient-Generated Subjective Global Assessment (PG-SGA)** was designed to assess nutritional status in cancer patients and includes patient input on weight loss, symptoms, nutritional intake, and functional capacity.
• The Mini Nutritional Assessment (MNA) was designed for use with older patients and includes anthropometric measurements including calf and arm circumferences, BMI, and weight loss. In addition, the MNA assesses lifestyle, mobility, and medication usage. The MNA contains a dietary questionnaire to measure food and fluid intake and autonomy of feeding. This tool calls for the clinician to make a subjective assessment of the patient’s perception of his or her health and nutrition status. The assessment takes about 15 minutes to complete and categorizes patients into one of three nutritional status levels: satisfactory, risk of malnutrition, and PEM.

A shorter version of the MNA is also available.

• The Nutritional Risk Index (NRI) is derived from ALB concentration and the ratio of actual to usual weight, as follows:

\[
NRI = (1.519) \text{ALB (g/L)} + (41.7) \frac{\text{present weight}}{\text{usual weight}}
\]

Scores fall into one of four categories: not malnourished, >100; mildly malnourished, 97.5–≤100; moderately malnourished, 83.5–<97.5; and severely malnourished, <83.5. Although accurate, the utility of the NRI is limited because it is impractical to administer in the community setting.

References


Nutrition Intervention: Improving Outcomes and Reducing Health Care Costs

- Decreased Morbidity
- Decreased Mortality
- Improved Quality of Life and Functioning
- Reduced Length of Hospital Stay and Admissions
- Reduced Health Care Costs

References
Just as a wealth of research reveals the harmful outcomes and high costs of malnutrition, many studies confirm the benefits of nutrition intervention for poorly nourished patients. Providing nutrition support to these patients helps decrease morbidity and mortality, improve QOL, and decrease LOS and care costs.

In most of the studies below, the nutrition intervention included provision of oral supplements that provided protein, calories, and important micronutrients.

### Nutrition Intervention Is Associated With Decreased Morbidity

- In a study of 181 older adult orthopedic patients, only 14 of those given two protein-calorie supplements a day experienced major complications compared to 33 patients who did not receive supplementation. The total number of complications in the supplemented group was 22, while the total in the unsupplemented group was 55 (see table below).

<table>
<thead>
<tr>
<th>Major complications</th>
<th>Supplemental Nutrition (n = 84)</th>
<th>Standard Nutrition (n = 97)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant anemia</td>
<td>0 (0%)</td>
<td>7 (7.2%)</td>
</tr>
<tr>
<td>Bone fusion failure</td>
<td>0 (0%)</td>
<td>4 (4.1%)</td>
</tr>
<tr>
<td>Wound and joint infection</td>
<td>11 (13.1%)</td>
<td>21 (21.6%)</td>
</tr>
<tr>
<td>Pressure ulcer</td>
<td>1 (1.2%)</td>
<td>4 (4.1%)</td>
</tr>
<tr>
<td>Septicemia</td>
<td>0 (0%)</td>
<td>1 (1.0%)</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>1 (1.2%)</td>
<td>3 (3.1%)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3 (3.6%)</td>
<td>6 (6.2%)</td>
</tr>
<tr>
<td>Other</td>
<td>6 (7.2%)</td>
<td>9 (9.4%)</td>
</tr>
<tr>
<td><strong>Total major complications</strong></td>
<td><strong>22</strong></td>
<td><strong>55</strong>*</td>
</tr>
</tbody>
</table>
| **Total patients with major complications**| **14 (16.6%)** | **33 (35.1%)****

*P = 0.0002

**P = 0.005
• In a study of 63 patients with acute pancreatitis, late pulmonary complications were significantly less frequent in patients who received enteral feeding following surgery than in those who did not (15% of enterally fed vs 43% of standard-nutrition patients, $P < 0.05$). Delayed renal insufficiency and catheter and wound sepsis were also more frequent in patients not receiving enteral supplementation ($P < 0.05$).

• Undernourished older adult patients often suffer from a severely “damaged” immune response. A review of studies showing the outcomes of providing older adults with commercial, oral nutritional supplements concluded that supplementation can help boost immune defense mechanisms and improve response to vaccines.

• In a study of 305 patients with cancer of the gastrointestinal tract, patients were randomly assigned to (1) receive an immune-enhancing enteral supplement before surgery, (2) receive the supplement before and after surgery, or (3) not receive the supplement. The incidences of infections in groups 1 and 2 were 13.7% and 15.8%, respectively, compared to 30.4% in the third ($P = 0.006$ vs preoperative supplementation and $P = 0.02$ vs pre-and postoperative supplementation).

• A meta-analysis of five randomized controlled trials that included a total of 1224 older adult patients showed that oral nutritional supplementation can significantly reduce the risk of developing pressure ulcers in that population (by 25%).

• In a study of 50 home-dwelling older adults referred to a nursing service for wound management, provision of energy-and protein-dense oral supplements significantly improved some indices of wound healing and cognitive function.

• A total of 152 patients undergoing surgery of the lower gastrointestinal tract were randomized to one of four groups: group 1 was supplemented before and after surgery; group 2 was supplemented only before surgery; group 3 was supplemented only after surgery; and group 4 was given no nutritional supplements. Significantly fewer minor complications were seen in groups 1 and 3 than in group 4 ($P < 0.05$) (see table below).

<table>
<thead>
<tr>
<th></th>
<th>Before &amp; After $(n = 32)$</th>
<th>Before Only $(n = 41)$</th>
<th>After Only $(n = 35)$</th>
<th>No Suppl $(n = 44)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative LOS (days)*</td>
<td>11.7(5.1)</td>
<td>12.8(4.5)</td>
<td>13.4(7.5)</td>
<td>14.1(6.6)</td>
</tr>
<tr>
<td>Minor complications</td>
<td>10†</td>
<td>17</td>
<td>13†</td>
<td>30</td>
</tr>
<tr>
<td>Major complications</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total complications</td>
<td>15</td>
<td>20</td>
<td>15</td>
<td>34</td>
</tr>
</tbody>
</table>

*Values are mean(standard deviation)
†$P < 0.05$ vs group 1, no nutritional supplements
Nutrition Intervention Is Associated With Decreased Mortality

- Two reviews of published reports suggest that nutritional supplementation, orally or via enteral tube feeding, may reduce mortality risk. In a review of 59 studies of the outcomes of nutrition intervention with oral or tube-fed supplements, five studies, including two randomized controlled trials, found improved mortality with supplementation. In a systematic review of 32 studies, a non-significant trend in favor of supplementation and reduced mortality was noted.10,11

- At hospital admission, 381 older hospitalized adults were stratified into one of three nutritional categories, from “severely undernourished” to “adequately nourished” and randomly assigned to control or to receive nutritional supplements three times a day. In the most poorly nourished patients, the intervention was associated with reduced mortality (5/34 vs 14/40, \( P < 0.05 \)).12

- In a study of 63 patients with severe acute pancreatitis, mortality was more than four times as common among those who did not receive enteral supplementation than among those who did.4

- Among 59 older adult patients with femoral neck fractures roughly evenly divided to receive or not receive oral supplements, six who were not supplemented died within a 6-month follow-up interval, while no patients in the supplemented group died.13

- In a 2-year study of 137 patients with colorectal or gastric cancer, there was a non-significant trend (\( P = 0.3 \)) toward longer survival among those randomized to receive individual support that included nutrition intervention than among those who received group support and standard care.14

Nutrition Intervention Is Associated With Improved Quality of Life and Functioning

- Eighty-four studies of the use of oral nutritional supplements by people with chronic conditions in the community were systematically reviewed. The results showed that supplementation typically had a positive effect on functioning—for instance, improved muscle strength, walking distance, and well-being in patients with chronic obstructive pulmonary disease, and a reduction of falls and increased ability to perform ADLs in older adults.15

- Of 107 patients with unresectable pancreatic cancer and a weight loss of >25% over several months, 63 stabilized their weight over an 8-week period by consuming an oral supplement. Global QOL scores were significantly higher among these patients than among those whose weight was not stabilized (\( P = 0.037 \)). The mean difference in QOL scores was considered clinically significant.16
• In an analysis of metabolic data from 19 home-living cachectic patients with advanced pancreatic cancer, the investigators saw a significant increase above baseline in physical activity level (PAL) among patients receiving an oral supplement containing an n-3 fatty acid ($P < 0.05$) (see figure below). PAL was defined as the ratio of total energy expenditure to resting energy expenditure. The investigators suggest that increased PAL reflects improved QOL.

• A total of 101 hospitalized patients were randomized to receive either an oral nutritional supplement after surgery or standard postsurgical care and followed for 10 weeks. The nutritional status of patients in the treatment group improved significantly, as did a QOL measure, compared to those in the control group ($P < 0.001$).

Nutrition Intervention Is Associated With Reduced Length of Hospital Stay and Admissions

• In the study of 59 patients with femoral neck fractures (reference 11), the median LOS of those who received oral supplements was 16 days shorter than that of those given no supplements ($P < 0.02$).

• Thirty-six patients undergoing pancreaticoduodenectomy were randomly assigned to receive routine postsurgical treatment or a double-lumen gastrojejunostomy tube for enteral feeding. Patients who received the enteral tube feeding had a significantly shorter LOS than those who did not (mean 11.5 ± 2.9 days vs 15.8 ± 7.8 days, $P = 0.01$).

• A total of 305 patients with cancer of the gastrointestinal tract were randomly assigned to (1) receive an immune-enhancing enteral supplement before surgery, (2) receive the supplement before and after surgery, or (3) not receive the supplement. The mean LOS in the first group was 11.6 ± 4.7 days; in the second, 12.2 ± 4.1; and in the third, 14.0 ± 7.7 ($P = 0.008$ vs preoperative supplementation and $P = 0.03$ vs pre-and postoperative supplementation).

* $P = 0.05$, change from baseline

<table>
<thead>
<tr>
<th>Control (n = 12)</th>
<th>Supplement (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition</td>
<td>Nutrition</td>
</tr>
</tbody>
</table>

Eighty-three community-dwelling older adults at risk for malnutrition were randomized to either receive nutrient-dense oral supplementation or be entered into a control group. After 16 weeks, the supplemented group was significantly better in two measures—emotional role functioning ($P < 0.01$) and days spent in bed ($P = 0.04$)—than controls.

Sixty cancer outpatients receiving radiotherapy to the gastrointestinal or head/neck area were randomized to either receive intensive nutrition counseling and, if appropriate, oral supplements or usual care. The supplemented group had significantly smaller deterioration in global QOL than the control group ($P = 0.009$).
In a study of 81 patients undergoing colorectal resection surgery, those who were given traditional peri-operative nutrition care (pre-operative fasting and delayed reintroduction of oral nutrients after surgery) had a significantly longer LOS than did those treated according to an enhanced-recovery nutrition pathway (carbohydrate and fluid loading before surgery and early post-surgical oral feeding). The median LOS was 10 days with traditional feeding compared to 7 days with the enhanced-recovery nutrition care \( (P < 0.01) \).\(^{23}\)

In a retrospective review of the UK General Practice Research Database, annual health care usage of 252 people who had received at least one prescription for a sip feed supplement in 2000 or 2001 was compared to that of matched controls. Controls required 18.0 visits to a general practitioner per year, compared with those prescribed sip feeds, who required 15.7 visits per year. Controls required 0.5 hospitalizations per year compared with those prescribed sip feeds, who required 0.3 hospitalizations.\(^{24}\)

Nutrition Intervention Is Associated With Reduced Health Care Costs

In a study of 311 older adults living in the community, it was found that the cost of a high-energy, high-protein oral nutritional supplement was more than offset by reduction in the costs of medical services, including hospitalization, over a 12-month period.\(^{25}\)

A survey of 19 hospitals produced medical data for 1,767 medical and surgical patients. Of that total, 94% had at least one of eight risk factors for malnutrition. The at-risk patients who received “high-quality” nutrition care that included early nutrition intervention with a nutritional product or feeding had an average LOS of 12.2 days, compared to 14.4 days for those who received “low-quality” care. The estimated potential net savings of providing high-quality nutrition care to the rest of the at-risk patients totaled $1,778,143—or $1,064 per patient.\(^{26}\)

Among 181 older adult patients in the United Kingdom hospitalized following orthopedic surgery, the median costs of hospital stay were £2068 (US $3,447 in 1997) in the supplemented group and £2199 ($3,665) in the control group. The mean daily cost of treatments to prevent or treat complications (eg, antibiotics and blood transfusions) was £30.16 ($50.28) for those patients who received two oral nutritional supplements a day. The cost for those given only the standard diet was £46.23 ($77.07) (see figure below).\(^3\)
• In a study of 36 patients who underwent pancreaticoduodenectomy, hospital charges for those randomly assigned to receive routine post-surgical treatment were $82,151 ± 56,632 compared to $52,589 ± 15,964 for those who were fed enterally via a double-lumen gastrojejunostomy tube (P = 0.036).22 (See figure below.)

• At one hospital, a comprehensive program developed to address inpatient malnutrition resulted in a savings of $2.4 million over a 2-year period due to decreased LOS; the savings was estimated at $1,000 for each patient at high risk of malnutrition. Complication rates and mortality were also significantly reduced.27,28
Malnutrition in the Elderly


Another Dimension of Malnutrition: Health Risks of Obesity

Increased Morbidity
Increased Mortality
Increased Hospital Stays
Increased Health Care Costs

References
About 60 million adults in the United States—nearly a third of the adult population—are obese.\(^1\) Because obesity is linked to a number of serious diseases such as cardiovascular disease, hypertension, diabetes, some types of cancer, and osteoarthritis, it takes an enormous toll on the health of people in this country. About 300,000 deaths a year result from obesity-related diseases.\(^2\)

Furthermore, obesity’s contribution to rising health care costs is staggering: In 2003, the direct health costs attributable to obesity were $75 billion.\(^1\) Indirect costs—for instance, from absenteeism and loss of productivity—add billions more.

Obesity is another outcome of malnutrition—specifically, of overnutrition of energy. Obesity is usually defined in terms of BMI, with people whose BMI value is 30 or above being considered obese. (People with BMI values between 25 and 29.9 are considered overweight.) Some reports use subcategories of obesity, as follows:\(^3\):

- Class 1, BMI 30–34.9 kg/m\(^2\)
- Class 2, BMI 35–39.9 kg/m\(^2\)
- Class 3, BMI ≥40 kg/m\(^2\)

The higher the class of obesity, the greater the negative implications for health—and the prevalence of class 3 obesity increased nearly 3-fold between 1990 and 2000.\(^3\)

It is important to note that although obese people are typically considered to be overnourished, their obesity can mask serious protein and micronutrient deficits. Protein undernutrition is especially problematic for obese surgical or critically ill patients, who are at risk for decreased immune status and impaired wound healing. Unaware of the deficits, clinicians may not provide obese patients with adequate nutritional intervention.\(^4-9\)

Obesity Is Associated With

**Increased Morbidity**

- Overweight and obesity increases risk for developing type 2 diabetes. In the 1999–2002 National Health and Nutrition Examination Survey, the prevalence of overweight/obesity among people with diabetes was 85.2% and the prevalence of obesity was 54.8%.\(^10\)

  - In a retrospective review of the medical records of 1,179 trauma patients, researchers found that complications were more than 50% more common among obese patients (BMI ≥35) than among non-obese patients (P = 0.02).\(^11\)

---

**In the last 25 years, overweight rates have doubled among children and tripled among adolescents.**\(^1\)

By 2000, about 9 million children and adolescents were overweight or obese.\(^2\)

Among overweight 5– to 10-year-olds, 61% already have at least one risk factor for heart disease.\(^1\)

---

**By 2010, according to some predictions, 40% of all adult Americans will be obese.**\(^2\)

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**Diabetes increases risk for several serious conditions**

- Cardiovascular disease
- Peripheral vascular disease
- Stroke
- Retinopathy
- Kidney disease
- Neuropathy
- Impaired wound healing
- Impaired immune function
• In a prospective cohort study of 21,414 US male physicians, researchers found that for those with a BMI ≥30, the adjusted relative risk of stroke was 2.00 (95% confidence interval, 1.48–2.71) compared to those with a BMI <23. Each BMI-unit increase was associated with a significant 6% increase in the adjusted relative risk of total, ischemic, and hemorrhagic stroke.12

• An analysis of data collected from about 10,000 respondents in a national household telephone survey compared the negative effects of obesity, twenty years of aging, smoking, and problem drinking on health and health care costs. The figure below shows the odds ratios for selected diseases related to these parameters. Obesity and aging had significantly greater effects on heart disease, hypertension, and diabetes than smoking and problem drinking ($P <0.05$). Obesity was significantly associated with an odds ratio >1 (indicating increased risk) for every disease.13

• A meta-analysis of clinical studies of type 2 diabetes indicated that 60% to 90% of type 2 diabetes may be related to obesity or weight gain. Furthermore, obesity or weight gain can increase risk for developing diabetes more than 90-fold and risk for coronary heart disease (in women) 6-fold.14

• Data for 16,884 adults from the Third National Health and Nutrition Examination Survey (NHANES III) were analyzed to assess the relationship between BMI and several chronic health conditions—type 2 diabetes, gallbladder disease, coronary heart disease (CHD), high cholesterol level, high blood pressure, and osteoarthritis. With normal-weight individuals used as reference, the prevalence ratio (PR) for most of the health outcomes increased with increasing severity of overweight/obesity. In both men and women <55 years with a BMI ≥40, PRs were highest for diabetes (18.1, 95% confidence interval [CI] 6.7–46.8, and 12.9, CI 5.69–28.05, respectively) and gallbladder disease (21.1, 95% CI 4.1–84.2, and 5.2, CI 2.9–8.9).15

Odds Ratios For Selected Physical Conditions Related to Obesity, Aging, Smoking, And Drinking, 1998

<table>
<thead>
<tr>
<th>Condition</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>6</td>
</tr>
<tr>
<td>Hypertension</td>
<td>5</td>
</tr>
<tr>
<td>Asthma</td>
<td>4</td>
</tr>
<tr>
<td>Angina/heart disease</td>
<td>3</td>
</tr>
<tr>
<td>Lung disease</td>
<td>2</td>
</tr>
</tbody>
</table>

Sources: Author’s calculation based on data from the Healthcare for Communities (HCC) survey, wave 1.

• Ten-year data on men and women participants of two large prospective cohort studies were analyzed to assess the association between excess weight and risk for developing several chronic diseases. Compared to men and women a BMI of 18.5–24.9, those with a BMI of >35 were approximately 20 times more likely to develop diabetes. Overweight (not obese) women were significantly more likely than normal-weight peers to develop gallstones (relative risk [RR], 1.9), hypertension (RR, 1.7), high cholesterol level (RR, 1.1), and heart disease (RR, 1.4).16

Obesity Is Associated With Increased Mortality
• In a retrospective review of the medical records of 1,179 trauma patients, the mortality of obese patients was 10.7% compared to 4.1% among non-obese patients ($P = 0.003$).11
• Among 3457 participants in the prospective Framingham Heart Study (40+ years of follow-up), those who were overweight or obese had shortened life expectancies. On average, those who were obese at age 40 years lived 6 to 7 years less than normal-weight counterparts. Those who were obese and smoked lived 13 to 14 years less than normal-weight nonsmokers.17
• Using data from the National Health and Nutrition Examination Surveys, researchers determined excess mortality in the year 2000 associated with various BMI levels. They found that relative to the normal-weight category, obesity (BMI >30) was associated with 111,909 excess deaths.24

• Data from a large ($n >1,000,000$) 14-year prospective study indicated that risk of death increased with an increasing BMI in all age groups and for all categories of cause of death. White men and women in the highest BMI categories had an increased relative risk of death of 2.58 and 2.00, respectively, compared to those whose BMI was 23.5–24.9.25
• Based on data from several National Health and Nutrition Examination Surveys and studies, years of life lost (YLL) due to obesity were derived for adults aged 18–85 years. For white men aged 20–30 years whose BMI is >45, the maximum YLL is 13; for women, it is 8. For men, this figure can represent a 22% reduction in expected remaining life span.26

The Obesity Paradox
The data in this section refer to the association between obesity and mortality in the general population. Other data show that in some specific populations—patients on hemodialysis, adults >65 years, and people with heart failure, AIDS, and cancer—some excess weight seems to be protective and has a positive effect on mortality.18-23
Obesity Is Associated With

**Increased Hospital Stays**

- In a retrospective review of the medical records of 1,179 trauma patients, researchers found that obese patients had an average LOS of 7 days compared to 4.7 days for non-obese patients ($P = 0.001$). The average intensive care unit LOS for obese patients was also longer—$8.7$ vs $6.1$ days ($P = 0.045$).\(^{11}\)
- Data derived from the NHANES I (First National Health and Nutrition Examination Survey) Epidemiologic Followup Survey were examined to determine the relationship between BMI and LOS at four time intervals from 1971–1992. Results showed that overweight and obese participants had a greater crude LOS than normal-weight (BMI 18.5–<25.0) participants. The table below shows the increase in LOS ratios with increased BMI at the most recent time interval.\(^{27}\)

<table>
<thead>
<tr>
<th>BMI (kg/m(^2))</th>
<th>1986–1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;18.5</td>
<td>1.01 (0.61, 1.68)</td>
</tr>
<tr>
<td>18.5–&lt;25.0</td>
<td>1.09 (0.82, 1.45)</td>
</tr>
<tr>
<td>25.0–&lt;30.0</td>
<td>1.36 (1.03, 1.79)</td>
</tr>
<tr>
<td>30.0–&lt;35</td>
<td>1.60 (1.19, 2.16)</td>
</tr>
<tr>
<td>&gt;35</td>
<td>2.31 (1.68, 3.18)</td>
</tr>
</tbody>
</table>

* Compared to participants with the shortest LOS—those with a BMI of 18.5–<25.0 in the 1971–1975 survey.

- Use and costs of health care services were determined for 17,118 members of a large health maintenance organization (HMO) over a 1-year period. Researchers found a strong association between BMI and hospital inpatient days, adjusted for age and sex. Compared to members with a BMI of 20–24.9, there was decreased use of inpatient services for those with BMIs of 25–29.9, but increased use among those moderately (BMI 30–34.9) and severely (BMI ≥35) obese (34% and 74% higher rates, respectively).\(^{28}\)

**Obesity Is Associated With**

**Increased Health Care Costs**

- In the HMO study described above, mean total health care costs were 25% greater among those with a BMI of 30–34.9 and 44% greater among those with a BMI of ≥35 than those of patients with a BMI 20–24.9. According to the researchers, “The association between BMI and coronary heart disease, hypertension, and diabetes largely explained these elevated costs.”\(^{28}\)
- Medicare data from 1984 to 2002 were linked with baseline data from an earlier heart association project (1967–1973) for 9,978 men and 7,623 women. Participants were classified according to baseline BMI as nonoverweight, overweight, obese, and severely obese. Average annual and cumulative Medicare charges by sex and BMI categories are shown below.\(^{29}\)

<table>
<thead>
<tr>
<th>Nonoverweight</th>
<th>Overweight</th>
<th>Obese</th>
<th>Severely Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Annual Medicare Charges ($)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>7,205</td>
<td>8,390</td>
<td>10,128</td>
</tr>
<tr>
<td>Women</td>
<td>6,224</td>
<td>7,653</td>
<td>9,612</td>
</tr>
<tr>
<td>Cumulative Medicare Charges ($)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>100,431</td>
<td>109,098</td>
<td>119,318</td>
</tr>
<tr>
<td>Women</td>
<td>76,866</td>
<td>100,959</td>
<td>125,470</td>
</tr>
</tbody>
</table>

* $P <0.001$ for trend
• A retrospective study of members of a large HMO over a 9-year period examined the relationship between obesity as indicated by BMI and future health care costs. For members with a BMI 20–24.9, the mean annual cost of all medical care was $1,631. The cost for overweight members (BMI 25–29.9) was 10% higher, while the cost for obese members (BMI ≥30) was 36% higher. The cumulative 9-year health care costs averaged $15,583, $18,484, and $21,711 for members with BMIs of 20–24.9, 25–29.9, and >30, respectively (see figure below).\textsuperscript{30}

- The use and costs of medical services for 509 new adult patients at a university medical center were monitored for a year. Obese patients (BMI >30) used primary care, specialty care, and diagnostic services significantly more often than nonobese patients, and, as shown in the table below, accrued significantly higher care charges.31

<table>
<thead>
<tr>
<th>Type of charges ($)</th>
<th>Obese Patients (n = 205)</th>
<th>Nonobese Patients (n = 301)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary care</td>
<td>383 (324)</td>
<td>292 (260)</td>
<td>0.0058</td>
</tr>
<tr>
<td>Specialty care</td>
<td>603 (1,758)</td>
<td>409 (1,003)</td>
<td>0.0062</td>
</tr>
<tr>
<td>Emergency department</td>
<td>542 (1,654)</td>
<td>312 (1,360)</td>
<td>0.0484</td>
</tr>
<tr>
<td>Hospital</td>
<td>5,310 (20,355)</td>
<td>3,065 (16,011)</td>
<td>0.0485</td>
</tr>
<tr>
<td>Diagnostic services</td>
<td>1,366 (2,366)</td>
<td>1,006 (1,532)</td>
<td>0.0021</td>
</tr>
<tr>
<td>Total charges</td>
<td>8,205 (22,727)</td>
<td>5,083 (17,445)</td>
<td>0.0033</td>
</tr>
</tbody>
</table>

*P values are for the natural logarithm of these charges + $10.00 to reduce the influence of outliers.

- In a retrospective study of 539 obese and 1,225 nonobese members of a health insurance plan, researchers found that those who were overweight/obese (BMI >25) had significantly more hospitalizations, outpatient visits, professional claims, and prescription drug use than those who were normal weight. Thus, the median 1-year health care costs for overweight/obese members was $585.44, while the costs for normal-weight members was $333.24 (P < 0.001). For each BMI-unit increase, costs increased 2.3% (P < 0.001).33

- Data from the biennial Health and Retirement Study for 7,971 individuals were analyzed to examine the impact of obesity on health care costs. Compared with costs for normal-weight people, costs for those with a BMI of 30–35 were about 25% higher; costs for people with a BMI of 35–40 were about 50% higher; and costs for those with a BMI >40 were about 100% higher.34

- A total of 424 patients from several medical clinics were enrolled in a study of obesity and health care costs. Researchers determined the waist circumference (WC) and BMI for each patient, and then obtained their care costs for the preceding year from clinic databases. Patients with a WC >103.5 cm generated 85% more inpatient charges than those with a WC <83.3.35
• A total of 510 surgically treated and 455 conventionally treated obese patients were followed for 6 years and their medication use and costs recorded. The average annual cost for diabetes and cardiovascular disease medications increased by 96% among patients with a weight loss <5%, while the costs decreased by 8% among those with a weight loss ≥15%.³⁶

• An analysis of data collected from about 10,000 respondents in a national household telephone survey compared the negative effects of obesity, twenty years of aging, smoking, and problem drinking on health and health care costs. Obesity was associated with a statistically significant average increase in health care costs of $395 a year, compared to $225 for aging, $230 for current or ever smoking, and $150 for problem drinking.¹³

• Data for 9,867 adults were derived from three national surveys (1998 Medical Expenditure Panel Survey and the 1996 and 1997 National Health Interview Surveys) to examine the relationship between obesity and direct medical care costs. The table below shows the estimated increases in per capita medical spending (standard errors in parentheses) attributed to obesity by insurance status.³⁷

<table>
<thead>
<tr>
<th>Insurance Category</th>
<th>Obesity-Related Spending Increase ($)</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-pocket</td>
<td>125* (33)</td>
<td>26.1 (7.1)</td>
</tr>
<tr>
<td>Private</td>
<td>423* (167)</td>
<td>37.7 (15.0)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>864* (374)</td>
<td>39.1 (18.6)</td>
</tr>
<tr>
<td>Medicare</td>
<td>1,486* (730)</td>
<td>36.8 (19.6)</td>
</tr>
</tbody>
</table>

*P <0.05

The combined annual costs attributed to overweight and obesity in the United States are estimated to be nearly $93 billion (2002 dollars). Medicare and Medicaid pay about half these costs.³⁷
References


ANOTHER DIMENSION OF MALNUTRITION: HEALTH RISKS OF OBESITY
Nutrition Intervention in Obesity: Improving Outcomes

Benefits of Weight Loss

Meal Replacement Weight-Loss Strategies

References
Weight loss can significantly reduce the health risks of overweight and obese people. For obese people with type 2 diabetes, in fact, “weight management appears to be the most important therapeutic task.”

Health care professionals and patients alike know that losing weight and, especially, maintaining weight loss is challenging. Among the nutritional weight-loss strategies offered are a plethora of low-energy diets (LEDs) using regular table foods or pre-packaged meals, and medically supervised very-low-energy diets (VLEDs) in which all meals are replaced by a low-calorie nutritional product. Another nutritional strategy—using meal replacement (MR) shakes and bars for one or two meals a day—has been shown to be effective for weight loss, in part by providing structure and portion control to the diet and minimizing food decisions.

The research summaries that follow document the benefits of weight loss in reducing health risk factors, especially in people with type 2 diabetes, and the value of the MR nutritional strategies in weight loss programs.

It is important to note that although nutrition intervention to achieve weight loss is recommended for overweight and obese people in the general population, weight loss may not be the primary nutrition goal for seriously ill or older adult patients.
Benefits of Weight Loss

- In a review of weight loss strategies for obese patients with diabetes, the authors offer the following figure showing the positive effects of 12-week LEDs on weight, fasting plasma glucose (FPG) levels, lipids (cholesterol [Chol], low-density lipoproteins [LDL], and triglycerides [TG]), and systolic and diastolic blood pressure (SBP and DBP).²

Percentage change from baseline for 342 subjects in 18 studies


- In a prospective, randomized study of the effects of long-term LEDs and weight loss on markers of disease risk, 100 obese patients were assigned to one of two 3-month interventions: Group A was prescribed a 1,200–1,500 kcal/d diet, while group B was prescribed an isocaloric diet using MRs for two meals a day. After 3 months, all patients were placed on the same LED, using a MR for one meal a day, for 48 more months. Total mean weight loss was 3.3 ± 0.8% in group A and 8.4 ± 0.8% in group B. Both groups showed significant improvement in glucose, insulin, triglycerides, and systolic blood pressure, although improvements were more marked in group B.³

- A total of 75 obese patients with type 2 diabetes were randomized to one of three groups in a 12-week clinical study. The first group used a MR product containing lactose, fructose, and sucrose to replace three meals a day for 5 days, then to replace two meals a day for the duration of the study. The second group followed the same pattern using a MR product that contained oligosaccharides instead.

According to the American Diabetes Association, “moderate weight loss [5% of body weight] improves glycemic control, reduces CVD risk, and can prevent the development of type 2 diabetes” in those with a prediabetes condition.⁴
of fructose and sucrose. The third group followed a food exchange diet plan (EDP). Mean weight loss in the two MR groups was ~6.5% compared to 4.9% in the EDP group. Fasting glucose level was significantly reduced in the MR groups compared to the EDP group \((P = 0.012\), see figure below), as were total cholesterol and LDLs.\(^5\)

![Graph showing blood glucose levels over time](image)

Error bars represent 1 SEM from the mean.


- Eleven obese patients with type 2 diabetes followed a VLED (full meal replacement program) for 8 weeks. Mean body weight fell by about 11%. Fasting insulin, fasting blood glucose, hemoglobin \(A_1c\) (a measure of average glycemia over the previous 2–3 months), fasting plasma triglycerides, total cholesterol, and LDLs were all significantly reduced.\(^7\)

- A total of 113 overweight women enrolled in a 1-year weight reduction study were randomized into three intervention groups. Across all groups, a weight loss of 5% to 10% was associated with a significant \((P = 0.05)\) reduction in insulin level, total cholesterol level, and LDLs. A weight loss of \(\geq10\%\) was associated with additional significant \((P = 0.05)\) improvements in blood pressure and triglyceride level.\(^8\)

- Twelve-year follow-up data for 4,970 overweight people with diabetes were analyzed to compare overall death rates and death from CVD or diabetes between people with and without intentional weight loss. Intentional weight loss was associated with a 25% reduction in total mortality (rate ratios [RR] = 0.72, 95% CI 0.67–0.84) and a 28% reduction in CVD and diabetes mortality (RR = 0.72, CI 0.63–0.82).\(^9\)
Meal Replacement Weight-Loss Strategies

- In the meta- and pooling analysis described above (reference 5), subjects assigned to an MR group lost significantly more weight at 3 months and 1 year than those who followed a conventional reduced calorie diet—2.54 kg ($P < 0.01$) and 2.63 kg ($P < 0.01$) more, respectively. The dropout rate was significantly less in the MR group at 1 year.5

- Twenty-four studies of structured weight-loss programs were included in a meta-analysis of the effects of program type and intervention intensity on 24-week outcomes. Five types of programs were included: MRs, energy-restricted diets (>1,500 kcal/d), low-energy diets (800–1500 kcal/d), soy-based very-low-energy diets (<800 kcal/d), and other very-low-energy diets. Intensity scores for the programs were based on physician visits, clinic visits, and hours of class over 24 weeks. Very-low-energy diets produced significantly greater weight loss than any other type of program (21.3% of baseline body weight), but with the highest level of intensity. MRs were as effective as energy-restricted and low-energy diets in producing weight loss (9.1%, 8.5%, and 11.4%, respectively), and at the lowest level of intensity.10

- A total of 158 men and women were enrolled in a 5-year MR self-managed weight control program. After 5 years, men’s weight was $-5.8 \pm 5.4$ kg, and women’s was $-4.2 \pm 6.9$ kg. Among matched controls, men had gained $6.7 \pm 10.2$ kg, and women had gained $6.5 \pm 10.7$ kg.11

- Seventy-five overweight but otherwise healthy women were enrolled in a 1-year weight-loss study. They were randomly assigned to one of two diet plans—a traditional reduced-fat and reduced-calorie diet (TD), or an isocaloric plan that included one or more MRs a day. At 3 months, both groups had lost significant amounts of weight compared to baseline (TD, $-3.8 \pm 0.5$ and MR, $-6.3 \pm 0.6$ kg). At 1 year, the MR subjects had maintained their weight loss, while the TD subjects regained most of theirs. One-year treatment differences were significant for weight ($P < 0.001$) as well as for fat mass and percent fat (both $P < 0.002$).12

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group A (n = 23)</th>
<th>Group B (n = 26)</th>
<th>Group C (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight change (kg)</td>
<td>$-3.4 (5.4)$</td>
<td>$-7.7 (7.8)^*$</td>
<td>$-3.5 (5.5)$</td>
</tr>
<tr>
<td>Weight loss from baseline (%)</td>
<td>$-4.1 (6.4)$</td>
<td>$-9.1 (8.9)^*$</td>
<td>$-4.3 (6.5)$</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>$-1.0 (2.0)$</td>
<td>$-2.5 (2.7)^*$</td>
<td>$-1.3 (2.0)$</td>
</tr>
</tbody>
</table>

Mean (SD)

* $P \leq 0.05$ comparison between A vs B and B vs C
In a 1-year study of two weight-loss strategies, 61 overweight or obese people with type 2 diabetes were assigned to receive either standardized (educational) intervention or a combination intervention that also included 10–15 mg of sibutramine daily and use of MR products. At 1 year, compared to the standardized intervention, the combination intervention resulted in significantly greater weight loss (–7.3 ± 0.3 kg vs –0.8 ± 0.9 kg, P <0.001), as well as reduction in hemoglobin A1c (–0.6 ± 0.3% vs –0.0 ± 0.2%, P = 0.05).14

Sixty-six overweight and obese people were randomized into an MR group and a control group and followed for 6 months. The MR group replaced two meals a day with a MR product and consumed a low-fat evening meal. The control group followed a conventional low-fat, low-energy diet. Weight losses at 3 and 6 months were similar in the two groups. However, dietary compliance and convenience were viewed more favorably by those in the MR group than by those in the conventional diet group.17

Sixty-three obese patients with co-morbid conditions were provided with MRs to consume twice a day for 6 months along with one complete low-calorie meal. Although the patients had been in the care of their primary care physician for the previous 6 months without losing a significant amount of weight, they experienced a mean decrease in body weight of 7% over the course of the study and a reduction in BMI from 40 to 37 kg/m² (P <0.05).18

A total of 492 healthy, overweight men and women in four high-stress occupations (police, firefighters, flight crew members, hospital health care professionals) were enrolled in a 12-week weight-loss study using MRs for two meals a day. The combined mean weight loss for men and women was 7.34 kg—significant weight loss compared to baseline (P <0.001). Flight crew members, who were recontacted at 15 months, had retained >80% of their 12-week weight loss.19

In a 1-year prospective study, 104 obese patients with type 2 diabetes were randomized to one of two interventions—either a soy-based MR plan or an individualized diet plan (IDP). The percentage weight loss was significantly greater in the MR group than in the IDP group (4.57 ± 0.81% vs 2.25 ± 0.72%, P <0.05), and metabolic parameters and C-reactive protein levels improved more in the former group, as well.20

For people with diabetes, MRs can make carbohydrate counting easier [because] the total number of grams is printed right on the package. MRs can also make it easy to eat the same amount of carbohydrate at the same time of day each day, [which] is recommended to help keep blood sugar levels stable.”21
• A total of 3,100 obese patients enrolled in a prospective weight-loss study were assigned to one of two 3-month interventions: Group A was prescribed a 1,200–1,500 kcal/d diet, while group B was prescribed an isocaloric diet using MRs for two meals a day. After 3 months, all patients were placed on the same LED, using a MR for one meal a day, for 48 more months. Total mean percentage weight loss at 3 months was 1.5 ± 0.4% in group A compared to 7.8 ± 0.5% in group B. Four years later, mean weight loss was 3.3 ± 0.8% in group A and 8.4 ± 0.8% in group B.\(^3\)

• A total of 75 obese patients with type 2 diabetes were randomized to one of three groups in a 12-week clinical study. The first group used a MR product with a carbohydrate system that contained lactose, fructose, and sucrose to replace three meals a day for 5 days, then to replace two meals a day for the duration of the study. The second group followed the same pattern using a MR product that contained oligosaccharides instead of fructose and sucrose. The third group followed a food exchange diet plan (EDP). Mean weight loss in the two MR groups was ~6.5% compared to 4.9% in the EDP group (\(P = 0.009\)), as shown in the figure below.\(^4\)

![Graph showing weight loss over time for EDP and MR groups.](Image)

Error bars represent 1 SEM from mean.

References

Conclusion
A vast amount of research reveals the high prevalence and poor outcomes of malnutrition—both undernutrition (PEM) and overnutrition—in the United States. Malnutrition is common in the United States.

- As many as half of hospitalized patients are undernourished.
- Up to 85% of LTC residents have or are at risk for PEM.
- About 60 million adults—nearly a third of the adult population—are obese.

Both major types of malnutrition are linked to poor health outcomes.

- PEM is significantly associated with increased morbidity such as infections and pressure ulcers and increased mortality.
- Obesity is significantly associated with increased morbidity such as type 2 diabetes and heart disease and increased mortality.

Both major types of malnutrition are linked to significantly increased LOS and health care costs.

- The average LOS of malnourished (PEM) patients is as much as 61% longer than that of well-nourished patients, and their care costs are significantly higher.
- The average LOS of obese patients is as much as twice that of normal-weight patients, and their care costs are significantly higher.

Research also reveals that these poor outcomes and increased costs can be avoided by appropriate nutrition intervention.

- Providing nutritional formulas as supplements for undernourished patients reduces risk for negative health outcomes, and reduces health care costs.
- Using nutritional formulas to replace foods in the diet of overweight and obese patients helps them lose weight, reduces risk for negative health outcomes, and are cost effective.

At a time when health care costs are skyrocketing, health care decision-makers can ill afford to ignore a relatively simple way to reduce the economic and human costs of malnutrition—screen patients for malnutrition, assess those at risk, and intervene nutritionally in those who can benefit.