COPD: Assessment of Energy Intake

The registered dietitian nutritionist (RDN) should assess the energy intake of adults with COPD. Evidence suggests there was improvement in dyspnea scores with higher energy intakes. In addition, less robust evidence supported a beneficial relationship with functional status, healthcare utilization or duration of illness.

**Recommendation(s)**

**COPD: Assessment of Energy Intake**

**Rating:** Fair

**Imperative**

- **Risks/Harms of Implementing This Recommendation**
  - There are no potential risks or harms associated with the application of the recommendation.

- **Conditions of Application**
  - There are no conditions which may limit the application of the recommendation.

- **Potential Costs Associated with Application**
  - Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN.

**Recommendation Narrative**

A total of nine studies were included in the evidence analysis supporting the recommendation:

- Four randomized controlled trials: One positive-quality (Sugawara et al, 2012), three neutral-quality (Forli and Boe, 2005; Planas et al, 2005; Weekes et al, 2009)
- Five cross-sectional studies: Three neutral-quality (Lee et al, 2013; Renvall et al, 2009; Yazdanpanah et al, 2010) and two negative-quality (Benton et al 2010; Selvi et al, 2014).

There was improvement in dyspnea scores with higher energy intakes, with less robust evidence supported a beneficial relationship with functional status, healthcare utilization or duration of illness.

- **Respiratory symptoms (three studies):** All three studies found significant associations with dyspnea scores (Lee et al, 2013; Sugawara et al, 2012; Weekes et al, 2009)
- **Functional status (one study):** The study found a significant association with activities of daily living scores (Weekes et al, 2009)
- **Healthcare utilization (one study):** The study found a significant association with number of infections requiring antibiotics (Forli and Boe, 2009)
- **Duration of illness (one study):** The study found a significant association with duration of disease in years (Selvi et al, 2014).

The findings for the impact of energy intake on exacerbations, quality of life (QoL), weight status and body composition were mixed, with the majority supportive of an association.

- **Exacerbations (two studies):** One study found a significant association with number of emergency room (ER) visits due to acute exacerbations (AEs) (Lee et al, 2013). One study did not find a association with number of ER visits due to AEs with energy intakes of either 1.7 x or 1.3 x Harris-Benedict Equation (HBE) (Planas et al, 2005).
- **QoL (three studies):** All three studies found significant associations of Chronic Respiratory Disease Questionnaire (CRQ) scores with energy intakes of 1.3 x HBE (Planas et al, 2005), CRQ scores (Sugawara et al, 2012) and St. George Respiratory Quotient (SGRQ) scores (Weekes et al, 2009). One study did not find significant associations for CRQ scores with energy intakes of 1.7 x HBE (Planas et al, 2005)
- **Weight status (seven studies)***
  - Six studies found significant associations
    - Weight gain with energy intakes of 1.7 x HBE (Planas et al, 2005)
    - Percentage IBW (Sugawara et al, 2012)
    - Weight gain (Forli and Boe, 2005; Sugawara et al, 2012; Weekes et al, 2009)
    - Body mass index (BMI) (Lee et al, 2013; Renvall et al, 2009).
  - Two studies did not find associations
    - BMI (Benton et al, 2010)
    - BW with energy intakes of 1.3 x HBE (Planas et al, 2005).
- **Body composition (three studies):** All three studies found significant associations with fat mass (FM), triceps skinfold (TSF) and fat-free mass index (FFMI) with energy intakes of 1.7 x HBE (Planas et al, 2005), FM, fat mass index (Sugawara et al 2012) and mid-arm circumference and sum of four skinfold thickness measurements (Weekes et al, 2009). All three studies also did not find associations with mid-arm muscle circumference (Weekes et al, 2009), FFMI and arm circumference (Sugawara et al, 2012) or FM, TSF and FFMI with energy intakes of 1.3 x HBE (Planas et al, 2005).

The evidence for a relationship between energy intake and lung function, systemic inflammation or exercise capacity was inconsistent.

- **Lung function (five studies):** Two studies found significant associations in forced vital capacity (FVC) and snifff pressure (Weekes et al, 2009) and Pmax inspiratory (PMmax) (Sugawara et al, 2012). Three studies did not find associations in FEV1 in second (FEV1) (Lee et al, 2013; Yazdanpanah et al, 2010), FEV1 with energy intakes of either 1.7 x or 1.3 x HBE (Planas et al, 2005), FVC, FEV1/FVC, and vital capacity (Yazdanpanah et al, 2010), PMmax and Pmax expiratory (PEmax) (Weekes et al, 2009) or PEmax (Sugawara et al, 2012).
- **Systemic inflammation (one study):** The study found a significant association with IL-6, but not CRP (Sugawara et al, 2012)
- **Exercise capacity (five studies):** Three studies found significant associations with upper and lower body strength (Benton et al, 2010) and six-minute walking distance (Benton et al, 2010; Lee et al, 2013; Sugawara et al, 2012). Two studies did not find associations: Handgrip strength (HGS) with energy intakes of either 1.7 x or 1.3 x HBE (Planas et al, 2005) and HGS (Weekes et al, 2009).

* For Sugawara et al, 2012, the workgroup considered the between-group analysis only in the conclusion statement.

**Recommendation Strength Rationale**

The conclusion statement supporting the recommendation was Grade II, Fair.

**Minority Opinions**

None.

**Supporting Evidence**

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).
What association exists between energy intake (e.g., kcal per kg) and outcomes in adults with COPD?

- References
  - Froli L, Boe J. The energy intake that is needed for weight gain in COPD candidates for lung transplantation. COPD 2005; 2:405-10
  - Selvi EC, Saikumar P, Kumar N. How to evaluate the risk of malnutrition in patients with COPD?. Global Journal of Medical Research: F Diseases 2014; 14:21-25
  - References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process

None.

Quick Links

- Chronic Obstructive Pulmonary Disease
- Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)

Recommendations Summary

COPD: Assessment of Body Weight 2019

Click here to see the explanation of recommendation ratings (Strong, Fair, Weak, Consensus, Insufficient Evidence) and labels (Imperative or Conditional). To see more detail on the evidence from which the following recommendations were drawn, use the hyperlinks in the Supporting Evidence Section below.

- Recommendation(s)

COPD: Assessment of Body Weight Status

The RDN should assess body mass index (BMI) or other measures of body weight in adults with COPD. Strong evidence suggests an association between body weight status and mortality in adults with COPD. The lowest BMI groups had higher mortality rates when compared to higher BMI groups. Furthermore, a BMI classification of approximately 25.0 kg/m² appeared to lower the risk of mortality when compared to both higher and lower BMI classifications. In unadjusted results, there was fair evidence of a positive association between BMI and lung function outcomes (FEV₁/FVC) in adults with COPD.

Rating: Strong

Imperative

- Risks/Harms of Implementing This Recommendation
  - There are no potential risks or harms associated with the application of this recommendation.

- Conditions of Application
  - There are no conditions which may limit the application of the recommendation.

- Potential Costs Associated with Application
  - Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN.

- Recommendation Narrative

Body Weight

A total of 22 studies were included in the evidence analysis supporting the recommendation:

- One negative quality case-control study (Dumov et al, 2013).

Body Weight and Lung Function Outcomes

All studies using FEV₁ % predicted as an outcome found a positive association with BMI or BMI category, and one longitudinal study showing increasing BMI reduced declines in FEV₁ % predicted over time. While these studies appear to indicate that increasing BMI is associated with improvements in FEV₁ % predicted, results did not include adjustment for relevant confounders and should be interpreted with caution. Results for other lung function measures (FEV₁, FVC, FVC % predicted, FEV₁/FVC) were mixed, and therefore, no conclusion can be drawn for these measures.

- FEV₁ stratified into quintiles and BMI (one study): One study (Abston et al, 2017) found BMI was not associated with FEV₁ in the overall group or in any of the FEV₁ quintiles. In each of the FEV₁ quintiles, FVC % predicted showed inverse associations with BMI, while FEV₁/FVC showed a positive association with BMI.
- BMI stratified into quintiles and FEV₁ (one study): One study (Lainscak et al, 2011) found a positive association between FEV₁ (ml/s) and BMI divided into quintiles in subjects hospitalized for an acute exacerbation of COPD (AECOPD), with FEV₁ increasing as BMI category increased.


Froli L, Boe J. The energy intake that is needed for weight gain in COPD candidates for lung transplantation. COPD 2005; 2:405-10


Selvi EC, Saikumar P, Kumar N. How to evaluate the risk of malnutrition in patients with COPD?. Global Journal of Medical Research: F Diseases 2014; 14:21-25


References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process

None.

Quick Links

- Chronic Obstructive Pulmonary Disease
- Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)
and O'Donnell et al) found that BMI was not associated with FVC. O'Donnell et al found BMI was not associated with FVC % predicted. Galeansu et al found NS association between FEV₁ and BMI, while Lim et al found FEV₁ to be highest in subjects classified as OB by either the WHO or Asian-Pacific methods of BMI. FEV₁ was not reported in four studies (Dimov et al; Hallin et al; O'Donnell et al; Qu et al).

Body Weight and Mortality Outcomes

The majority of studies comparing BMI (kg/m²) between survivors and non-survivors with COPD found survivors had a significantly higher BMI. Among studies comparing mortality rates between BMI categories, a lower risk of mortality was found as BMI classification increased. Likewise, those in the lowest BMI groups had higher mortality rates when compared to those in higher BMI groups. In studies evaluating BMI as a predictor of mortality, those in the lowest BMI categories consistently showed higher mortality risk when compared to those in higher BMI classifications. While increasing body weight appeared to be protective when BMI was evaluated as a continuous variable, studies evaluating BMI as a categorical variable found that a BMI of approximately 25.0-29.99 had a lower risk of mortality, when compared to both higher and lower BMI classifications.

- **BMI (mean ± SD) between survivors and non-survivors (five studies):** Five studies evaluated the difference in BMI between survivors and non-survivors with COPD. Four studies (Hallin et al, 2007; Marti et al, 2006; Ranieri et al, 2008; Tsimogianni et al, 2009) found significantly higher BMI in survivors vs. non-survivors. One study (Galesanu et al, 2014) found no differences in BMI between the groups.

- **Differences in Mortality Rates between BMI Categories (six studies):** Two studies (Abston et al, 2017; Lainscak et al, 2011) classified the BMI of patients into quintiles or quartiles (respectively) and found a lower risk of mortality as BMI categorization increased. In three studies that were not adjusted for confounding variables (Koul et al, 2017; Pothirat, et al, 2007; Uhl et al, 2011), two studies found higher mortality in the lowest BMI groups (Koul, Pothirat). Koul found higher mortality 2 years after AECOPD in the lowest BMI group compared to the next higher group (both with severe COPD). Uhl found NS differences in cumulative survival rate between all BMI groups. Zapatero found that the OB group (using ICD-9 codes) had a 51% reduction in risk of mortality, compared to NW group after adjusting for possible confounders in patients hospitalized for AECOPD.

- **BMI and weight status as a predictor of mortality (12 studies):**
  - Five studies evaluated BMI (or % reference weight) as a continuous variable as a predictor of mortality in subjects with COPD. Three studies (Galesanu et al, 2014; Ranieri et al, 2008; Schols et al, 2005) found BMI was a predictor of mortality in univariate analyses. Two studies (Jiang et al, 2017; Ranieri et al, 2008) reported BMI was a predictor of mortality in adjusted multivariate analysis. A fourth study (Galesanu et al, 2014) found NS association between BMI and mortality in adjusted multivariate analysis. The fifth study (Sindre et al, 2005) that used % reference weight did not find an association with mortality.
  - Seven studies evaluated BMI as a categorical variable as a predictor of mortality and adjusting for confounding variables (Hallin et al, 2007; Jiang et al, 2017; Marti et al, 2006; Piquet et al, 2013; Ruten et al, 2013; Tsimogianni et al, 2009; Yamauchi et al, 2014). Mortality risk was higher for subjects in the lowest BMI group (ranging from <18.5 to <25) when compared to higher BMI groups. Yamauchi found higher all-cause in-hospital mortality in the lowest BMI group and lower mortality in the higher BMI categories compared to the 18.5-22.9 group in an Asian population. Hallin found higher risk for 2-year mortality after AECOPD in all BMI categories compared to the 25-30 group. Marti found higher risk for both all-cause and respiratory mortality in the lower BMI groups compared to the 25-29.9 group and higher risk for all-cause mortality in the 20-24.9 group compared to the 25-29.9 groups. Piquet found no difference in risk for mortality between the lowest and 20-25 group, but a lower risk for mortality 48 months after AECOPD in the higher BMI categories. Ruten found the highest 2 and 3-year survival in subjects in BMI categories 25-29.99 compared to lower groups as well as those above 30. Jiang found a higher risk of mortality as BMI group classification decreased. Tsimogianni found that a BMI group of <25 had a higher risk of 3-year mortality.

### Recommendation Strength Rationale

Conclusion statements supporting the recommendation are Grade I, Good/Strong and Grade II, Fair.

### Minority Opinions

None.

### Supporting Evidence

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

**What effect does body weight have on mortality outcomes in adults with COPD?**

**What effect does body weight have on lung function outcomes in adults with COPD?**

### References

To calculate TEE in non-obese adults with COPD, the RDN may use 30kcal per kg body weight (BW) to estimate energy needs. Limited evidence suggests that 30kcal per kg body weight,

COPD: Estimating Total Energy Expenditure (TEE)

To calculate TEE in non-obese adults with COPD, the RDN may use 30kcal per kg body weight (BW) to estimate energy needs. Limited evidence suggests that 30kcal per kg body weight, in non-obese adults with COPD, produced an estimate that was not different from measured values on average, but whose variability was wide, indicating that estimation errors might be

Risks/Harms of Implementing This Recommendation

Predictive equations may under- or over-estimate energy needs in adults with COPD.

Conditions of Application

The Westerterp equation requires body composition measurements, fat-free mass (FFM) and body fat (BF), for calculation of RMR. Thus, its utility in clinical care may be limited.

The COPD: Estimating Total Energy Expenditure (TEE) recommendation applies to non-obese adults with COPD. Clinical judgement should be used in applying the recommendation to individuals with a BMI at or above 30kg/m².

The RDN should use clinical judgement in determining the body weight value used in calculations. Use of adjustments to body weight for obesity or volume status were not mentioned anywhere in the available studies.

For both RMR and TEE predictive equations, errors in individual estimates may be high. Calculation of energy needs (estimation) using a predictive equation is a starting point to determine energy requirements. Changes in body weight should be monitored as an indicator that energy needs should be re-evaluated. Over time, the monitoring of body weight and composition against energy intake is probably the most meaningful expression of energy requirements in COPD. It is important to remember in this type of assessment that if adverse changes in body weight or composition are occurring, equal attention should be paid to the possibility that the patient is not consuming the target intake or that the target intake is not correct.

Potential Costs Associated with Application

Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN.

Recommendation Narrative

A total of five studies were included in the evidence analysis supporting the recommendations:

Three cross-sectional studies: One positive-quality (Sinde et al, 2011); one neutral-quality (Faroq et al, 2015); one negative-quality (Ramos et al, 2016)]

Two diagnostic, validity or reliability studies: Both neutral-quality (Nordenson et al, 2010; Slinde et al, 2008).

Predictive Equations for Estimating RMR: A total of 11 equations were tested for validity in predicting RMR in adults with COPD. Two of these [Moore & Angelillo (MAE); Nordenson] were equations developed specifically for COPD patients, while the other equations were developed for healthy adults [Harris-Benedict (HBE); Milfin St. Jeor (MSJE); Westerterp; de Oliveira; Owen; four variations of Food and Agriculture Organization of the United Nations/World Health Organization/United Nations University (FAO/WHO/UNU)], which were WHO (including height), WHO (omitting height), Nordic Nutrition Recommendation (NNR), and the Scholfield equation. In two of the studies (Faroq et al, 2015; Sinde et al, 2011) these equations were evaluated as a starting point for estimating total energy expenditure (TEE).

Accuracy: Four of the 11 equations for predicting RMR were tested for accuracy, but only in one study (Sinde et al, 2008). Sinde et al, 2008, found that the Westerterp
equation yielded an accuracy rate of 68%, followed by the WHO (including height) equation (63%) and HBE (61%). The MAE had the lowest accuracy rate (51%).

Limit of Agreement (LOA): LOA was reported for nine equations. LOA as a percentage of the mean between measured and predicted RMR were -23% to +18% for the Westerterp equation (Slinde et al, 2008), about -28% to +10% for the MAE (in this case, the negative value is an overestimation) (Slinde et al, 2008), less than 25% for WHO (including height) equation and HBE, -40% to +40% for the de Oliveira equation (Ramos et al, 2016), -53% to +33% for the Owen equation (Ramos et al, 2016), -65% to +13% for the MSJE (Ramos et al, 2016), +19% for the Nordenson equation (Nordenson et al, 2010) and for WHO (omitting height) equation, +18% (Slinde et al, 2011), to as wide as -66% to +24% (Ramos et al, 2016).

Bias: Evidence suggests that the only unbiased estimator of RMR in adults with COPD was the de Oliveira equation. Four other equations were probably unbaised. These included the HBE and Westerterp equations, which might overestimate RMR and the Nordenson and WHO (including height) equations, which might underestimate RMR. Two equations (Owen and MSJE) were biased toward underestimation of RMR. The remaining four equations were probably biased toward overestimation of RMR (MAE, NNRE, Schofield and WHO (omitting height) equations). Evidence for the WHO (omitting height) equation suggests it might also underestimate RMR in adults with COPD.

Thus, the WHO (including height) equation and HBE seem to be equivalent to one another by the parameters of accuracy rate and LOA. If body composition measurements are known, then Westerterp is a better choice for calculation of RMR, because it yields a higher accuracy rate.

Predictive Equations for Estimating TEE: Two studies (Faroogi et al, 2015; Slinde et al, 2011) tested three methods for calculating TEE in adults with COPD. In the first method, a pedometer was used to estimate physical activity to compare against doubly labeled water (DLW) (Faroogi et al, 2015). In this method, a multiplier to RMR was assigned based on the number of steps taken and the multiplier was applied to six RMR equations [WHO (omitting height); Schofield; HBE; MAE; NNRE; Nordenson]). In the other study, motion and position sensors were used as the criterion method to measure TEE. For prediction purposes, two methods were used: The first was a simple ratio of 30kcal per kg body weight (BW); the second was to compute RMR using the WHO (omitting height) equation and then multiplying by 1.7 to calculate TEE (Slinde et al, 2011).

Accuracy: Only one of the two studies reported accuracy rate (Faroogi et al, 2015). Accuracy rate for the WHO (omitting height) equation x PAL was 67%, compared to 56% for the Schofield equation x PAL, 50% for HBE x PAL, MAE x PAL and NNRE x PAL, and 21% for the Nordenson equation x PAL.

LOA: The only estimation methods for which LOA was computed were 30kcal per kg and WHO (omitting height) x 1.7 (Slinde et al, 2011). LOA for both of these methods was 956kcal per day (-48, +48% of the mean between predicted and measured TEE).

Bias: The WHO (omitting height) x PAL and the MAE x PAL were probably unbiased, while the Schofield x PAL, HBE x PAL, NNRE x PAL and Nordenson x PAL equations were probably biased (toward underestimation) (Faroogi et al, 2016). An estimate of 30kcal per kg BW yielded a mean difference from measured TEE of 71kcal per day and so was probably unbiased, whereas another predictive method of WHO (omitting height) x 1.7 probably was biased toward overestimation, based on a mean difference from measured TEE of 319kcal per day (Slinde et al, 2011).

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked). The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

OVERALL: If measurements are not available, what are the best methods to predict energy needs in adults with COPD?

Recommendation Strength Rationale

- Conclusion statement supporting the recommendations is Grade III (Limited/Weak)
- None of the studies evaluating TEE methods were tested more than once
- Synthesis of results for RMR and TEE was challenging because large gaps exist in the available evidence (small numbers of studies with small sample sizes, inconsistency in the types of statistical treatments from study to study making data difficult to aggregate).

Minority Opinions

None.

Supporting Evidence

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

OVERALL: If measurements are not available, what are the best methods to predict energy needs in adults with COPD?

References


References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process

None.

Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)

Quick Links

Recommendations Summary

COPD: Assessment of Serum 25(OH)D Status 2019

Click here to see the explanation of recommendation ratings (Strong, Fair, Weak, Consensus, Insufficient Evidence) and labels (Imperative or Conditional). To see more detail on the evidence from which the following recommendations were drawn, use the hyperlinks in the Supporting Evidence Section below.

Recommendation(s)

COPD: Assessment of Serum 25(OH)D Status

The RDN should assess serum 25(OH)D levels in adults with COPD as part of a routine nutrition assessment. Evidence from 60% of studies reviewed, found positive associations between serum 25(OH)D and lung function measures.

Rating: Fair

Imperative
COPD: Assessment of Exacerbations

If an adult with COPD is having two or more exacerbations per year, the RDN should assess 25(OH)D levels. Limited evidence of vitamin D supplementation in adults with COPD supports improved exacerbation outcomes in those with baseline serum 25(OH)D levels ≤10ng per ml.

Rating: Fair

Conditions of Application:
- The recommendation COPD: Assessment of Exacerbations refers to COPD patients with frequent exacerbations, defined as two or more exacerbations per year (Hurst et al, 2010; Le Roux et al, 2018).
- Exacerbations are clinically defined as episodes of increasing respiratory symptoms, particularly dyspnea, cough and sputum production and increased sputum purulence (Wedzicha et al, 2017). The patient perception of an exacerbation is seeking treatment for symptoms; the research criteria is treatment with antibiotics or addition of increased inhaled or systemic steroids.
- Achievement of normal serum 25(OH)D levels may not be possible in all instances. Therefore, optimizing serum 25(OH)D levels is the goal (Rusinska et al, 2018).

Potential Costs Associated with Application:
- Costs may be incurred due to initial lab testing to evaluate serum 25(OH)D levels.

Recommendation Narrative:

COPD: Assessment of Serum 25(OH)D Status

A total of 29 papers from 28 studies provided evidence supporting the recommendation COPD: Assessment of Serum 25(OH)D Status.

- Four retrospective cohort studies: Three positive-quality (Berg et al, 2013; Malinovschi et al, 2014; Mekow et al, 2016) and one neutral-quality (Moberg et al, 2014).
- Two randomized controlled trials (RCT): One positive-quality (Sanjari et al, 2106) and one neutral-quality (Yumrutepe et al, 2015).
- One neutral-quality before-after study (Said and Abd-Elnaeem, 2015).
- One neutral-quality descriptive study (Gouda et al, 2016).
- One neutral-quality case-control study (Kunisaki et al, 2011).

The overall findings were as follows:


Mortality (five studies): NS relationships were found in any of the studies (Holmgaard et al, 2013; Mekow et al, 2016; Moberg et al, 2014; Persson et al, 2015; Puhan et al, 2014).

COPD: Assessment of Exacerbations

A total of eight studies were included in the evidence analysis supporting the recommendation COPD: Assessment of Exacerbations. Two of the studies evaluated exacerbation outcomes in those with serum 25(OH)D under 10ng per ml.

- Six RCTs: Four positive-quality (Lehouck et al, 2012; Martineau et al, 2015; Rafiq et al, 2017; Sanjari et al, 2015), one neutral-quality (Khan et al, 2017) and one negative-quality (Zendedel et al, 2015).
- Two before-after studies: Both neutral-quality (Rezk et al, 2015; Said and Abd-Elnaeem, 2015).

Seven studies tested oral vitamin D3 (cholecalciferol) ranging from 1, 200 IU daily for six months; subjects and controls could also take 400 IU vitamin D3 daily (Rafiq et al, 2017) to 120, 000 IU every two months (Martineau et al, 2015). One study administered 200, 000 IU cholecalciferol intramuscularly (IM) every four weeks for six months (Said and Abd-Elnaeem, 2015). All papers either cited the Endocrine Society Clinical Practice Guideline (ESG) (Holik et al, 2011) for serum 25(OH)D classifications or did not define classifications. In addition to the ESG reference, one study (Lehouck et al, 2012) defined "severe" vitamin D deficiency as serum 25(OH)D levels under 10ng per ml.


Five studies of vitamin D supplementation included subjects' pre- and post-supplementation levels, allowing changes in vitamin D status due to supplementation to be assessed. Results according to baseline (BL) and post-supplementation improvements in vitamin D status (ESG categories) are as follows:

- Deficient to sufficient 25(OH)D: Supplementation with 1, 200 IU D3 daily for six months (plus 400 IU daily, if desired) resulted in no impact on LF or AE outcomes (Rafiq et al, 2012). Supplementation with 100, 000 IU D3 every four weeks over 12 months resulted in a decrease in AE rate in a sub-group of subjects with "severe deficiency" [25(OH)D under 10ng per ml] (Lehouck et al, 2012).
- Insufficient to sufficient 25(OH)D: Supplementation with 100, 000 IU D3 every four weeks over 12 months resulted in no impact on AE or LF outcomes (Lehouck et al, 2012). Supplementation with either 5, 000 IU D3 or 0.25mcg calcitriol every four weeks over 12 months resulted in no impact on LF outcomes (Sanjari et al, 2016).
- Deficient to insufficient 25(OH)D: Supplementation with 50, 000 IU D3 per week for eight weeks, then 800 IU daily for 12 months resulted in a decrease in number of AEs and an improvement in maximum voluntary ventilation, but no impact on other LF outcomes in subjects with serum 25(OH)D under 10ng per ml at BL (Rezk et al, 2015). Supplementation with 120, 000 IU D3 every two months over 12 months resulted in improvement in AE severity and symptoms, but had no impact on other AE or LF outcomes (Martineau et al, 2015).

The remaining three studies did not report subjects' post-supplementation vitamin D status. One study (Said and Abd-Elnaeem, 2015) reported BL vitamin D status according to ESG categories, but did not report post-supplementation status. The second study (Khan et al, 2017) reported BL vitamin D status of subjects and controls combined and did not report pre- and post-supplementation status of subjects only. Finally, the last study (Zendedel et al, 2015) did not report either BL or post-supplementation vitamin D status.

- Insufficient 25(OH)D (subjects + controls): Supplementation with 2, 000 IU D3 per day for six months resulted in reduced AEs (Kahn et al, 2017). Supplementation with 200, 000 IU D3 IM every four weeks for six months, resulted in no impact in LF outcomes (Said and Abd-Elnaeem, 2015).
- Unknown 25(OH)D: Supplementation with 100, 000 IU D3 every month for six months resulted in improvement in LF outcomes and a reduction in AEs (Zendedel et al, 2015).

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Recommendation Strength Rationale

- Conclusion statements supporting both recommendations are Grade II, Fair
- For recommendation COPD: Assessment of Exacerbations: synthesis of the results was challenging due to lack of consistency in vitamin D dosing, dosing frequency and delivery routes, length of intervention and baseline serum 25(OH)D levels.

Supporting Evidence

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

What associations exist between serum 25(OH)D levels and mortality, lung function and exacerbation outcomes in adults with COPD?

Does vitamin D supplementation improve lung function and exacerbation outcomes in adults with COPD?

References

- Aragorn AR, Mofhatham PK, Shokeidas F, Ebrahimzadeh F, Pouma Y. Relationship between FEV1 and 25-hydroxy Vitamin D in patients with chronic obstructive pulmonary disease. Trends in Medical Research 2011; 8:184-190
- Kunisaki K, Niewoehner D, Singh R, Connett J. Vitamin D status and longitudinal lung function decline in the Lung Health Study. The European Respiratory Journal 2011; 37:238-43
- Shaheen S, Jameson K, Robinson S, Boucher B, Syddall H, Samek A, Cooper C, Holloway J, Dennison E. Relationship of vitamin D status to adult lung function and COPD. Thorax 2015; 70:305-12
The registered dietitian nutritionist (RDN) should provide MNT to adults with COPD to improve patient outcomes. Evidence indicates that MNT intervention provided by an RDN (or other registered dietitian) is associated with positive changes in nutritional status, improved quality of life, and decreased hospitalization rates in adults with COPD. The recommendations are based on the best available evidence and should be tailored to meet the individual needs of each patient. The recommendations are intended to be evidence-based and should be evaluated regularly to ensure that they remain aligned with the latest research findings.

In conclusion, the recommendations presented here are intended to guide the provision of MNT to adults with COPD. By following these recommendations, healthcare providers can help improve patient outcomes and quality of life for individuals with COPD.
Recommendation Narrative

A total of six papers reporting the results of five different studies were included in the evidence analysis supporting the recommendation:

- One positive quality randomized controlled trial (RCT) (van Wetering et al, 2010)
- Two positive quality papers from one before-after clinical trial (McDonald et al, 2016; McLaughlin et al, 2017 [which was a secondary analysis])
- One positive quality non-controlled trial (Farooqi et al, 2011)
- One neutral quality non-randomized trial (Norhall et al, 2009)
- One neutral quality prospective cohort (Gale et al, 2011).

Studies evaluated COPD subjects receiving MNT intervention by an RDN (or international equivalent), compared to COPD control groups receiving standard or usual care. The studies evaluated multidisciplinary interventions such as pulmonary rehab, which included MNT. All studies included individualized MNT in a one-to-one session (e.g., home visits, nutrition assessment and counseling) and as part of group education.

MNT and Weight Status, Quality of Life, Exercise Capacity Outcomes

Post-intervention results from six papers (five studies) (Farooqi et al, 2011; Gale et al, 2011; McDonald et al, 2016; McLaughlin et al, 2017; Norhall et al, 2009; van Wetering et al, 2010) were as follows:

- **Weight status** (six papers; five studies): Two papers reported improvements in body weight (Farooqi et al, 2011; McDonald et al, 2016) and percentage ideal body weight (Farooqi et al, 2011). Three papers reported body mass index (BMI) maintenance or improvements in BMI (McDonald et al, 2016; Norhall et al, 2009; van Wetering et al, 2010), while one paper did not report improvements in BMI (Gale et al, 2011). One paper did not find differences in percentage weight change (McLaughlin et al, 2017).
- **Quality of life (QOL)** (five papers; four studies): Four papers reported improvements in St. George's Respiratory Questionnaire scores (Gale et al, 2011; McDonald et al, 2016; van Wetering et al, 2010) and Three Factor Eating Questionnaire scores (McLaughlin et al, 2017), while one paper did not find significant improvements in Chronic Respiratory Disease Questionnaire scores (Norhall et al, 2009).
- **Exercise capacity** (five papers; four studies): All papers reported improvements in quadriceps average power (van Wetering et al, 2010), Short Physical Performance Battery tests (McDonald et al, 2016), total physical activity (McLaughlin et al, 2017), and walking distance, as measured by 6-minute walking distance (6MWD) (McDonald et al, 2016; van Wetering et al, 2010), 12MWD (Farooqi et al, 2011) and incremental shuttle walk test (Gale et al, 2011). One paper reported improvements in hand-grip strength (Farooqi et al, 2011).

MNT and Body Composition and Lung Function Outcomes

Post-intervention results of four papers (three studies) (McDonald et al, 2016; McLaughlin et al, 2017; Norhall et al, 2009; van Wetering et al, 2010) were as follows:

- **Body composition** (three papers; two studies): All reported improvements in body fat mass (McDonald et al, 2016), fat-free mass (van Wetering et al, 2010), percentage body fat (McDonald et al, 2016), waist circumference (McLaughlin et al, 2017) and waist to hip ratio (McDonald et al, 2016). One study did not find differences in skeletal muscle mass or appendicular skeletal muscle mass index (McDonald et al, 2016).
- **Lung function or respiratory impairment** (three studies): One study reported improvements in maximum inspiratory mouth pressure (P_{Imax}) (van Wetering et al, 2010), one study reported improvements in forced vital capacity (FVC) (McDonald et al, 2016), while one study did not find improvements in FVC (Norhall et al, 2009). Studies did not show improvements in forced expiratory volume in 1 minute (FEV) (McDonald et al, 2016; Norhall et al, 2009) and FEV/FVC, functional residual capacity, residual volume, expiratory reserve volume, or total lung capacity (McDonald et al, 2016). No negative outcomes in lung function parameters were found.

Recommendation Strength Rationale

- Conclusion statements supporting the recommendation are Grade I, Good/Strong (body weight status, QOL, exercise capacity outcomes) and Grade II, Fair (lung function, body composition outcomes).
- All studies were conducted outside the U.S.

Minority Opinions

None.

Supporting Evidence

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

What is the effectiveness of medical nutrition therapy as part of a multidisciplinary program on body weight, quality of life and exercise capacity outcomes in adults with COPD?

What is the effectiveness of medical nutrition therapy as part of a multidisciplinary program on body composition and lung function outcomes in adults with COPD?

References

- McLaughlin PE, McDonald VM, Gibson PG, Scott HA, Hensley MJ, MacDonald-Wicks L, and Wood LG. The Impact of a Weight Loss Intervention on Diet Quality and Eating Behaviours in People with Obesity and COPD. Nutrients 2017; 9:1147.

References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process


Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)

Quick Links

Recommendations Summary

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Recommendation(s)

COPD: Energy Prescription

For adults with COPD, the RDN should individualize the calorie prescription based on a nutrition assessment of energy intake, body weight and estimated energy needs to achieve and maintain an optimal weight status. Strong evidence indicates that the lowest body mass index (BMI) groups had higher mortality rates when compared to higher BMI groups. A BMI classification of approximately 25.0 kg/m² to 29.9 kg/m² appeared to lower risk of mortality when compared to both higher and lower BMI classifications. Furthermore, fair evidence suggests that higher energy intake improved dyspnea scores and also showed a beneficial but less robust relationship with functional status, healthcare utilization or duration of illness. In unadjusted results, fair evidence suggests a positive association between BMI and FEV₁ percentage predicted. In addition, an increasing BMI was also shown to reduce the longitudinal decline in FEV₁, percentage predicted over time.

Rating: Fair

Imperative

- Risks/Harms of Implementing This Recommendation
  There are no potential risks or harms associated with the application of the recommendation.

- Conditions of Application
  - The RDN should use clinical judgement in providing a calorie prescription. Calculation of energy needs (estimation) using a predictive equation is a starting point to determine energy requirements. Changes in body weight (BW) should be monitored as an indicator that energy needs should be re-evaluated. Over time, the monitoring of BW and composition against energy intake is probably the most meaningful expression of energy requirements in COPD. It is important to remember in this type of assessment that, if adverse changes in BW or composition are occurring, equal attention should be paid to the possibility that the patient is not consuming the target intake, or that the target intake is not correct.
  - An optimal body weight goal should be individualized for each patient.

- Potential Costs Associated with Application
  Costs may include expenses related to medical nutrition therapy (MNT) visits from an RN.

- Recommendation Narrative

Body Weight

A total of 22 studies were included in the evidence analysis supporting the recommendation:

- A total of 11 prospective cohort studies: Three positive-quality (Hallin et al., 2007; Schols et al., 2005; Tsmogianni et al., 2009) and eight neutral-quality (Abston et al., 2017; Bacciglu et al., 2014; Galesanu et al., 2014; Koul et al., 2017; Piquet et al., 2013; Pothirat et al., 2007; Qiu et al., 2009; Rutenberg et al., 2013) A total of 10 neutral-quality retrospective cohort studies (Jiang et al., 2017; Lainscak et al., 2011; Lim et al., 2017; Marti et al., 2006; O'Donnell et al., 2011; Raniere et al., 2008; Slinde et al., 2005; Uh et al., 2011; Yamauchi et al., 2014; Zapatero et al., 2013)
- One negative-quality case-control study (Dimov et al., 2013).

Body Weight and Lung Function Outcomes

All studies using FEV₁ percentage predicted as an outcome found a positive association with BMI or BMI category and one longitudinal study showed increasing BMI reduced declines in FEV₁ percentage predicted over time. While these studies appear to indicate that increasing BMI is associated with improvements in FEV₁, percentage predicted, results did not include adjustment for relevant confounders and should be interpreted with caution. Results for other lung function measures (FEV₁, FVC, FVC percentage predicted, FEV₁/FVC) were mixed and, therefore no conclusion can be drawn for these measures.

- FEV₁ stratified into quintiles and BMI (one study): One study (Abston et al., 2017) found BMI was not associated with FEV₁ in the overall group or in any of the FEV₁ quintiles. In each of the FEV₁ quintiles, FVC percentage predicted showed inverse associations with BMI, while FEV₁/FVC showed a positive association with BMI.
- BMI stratified into quintiles and FEV₁ (one study): Lainscak et al., 2011 found a positive association between FEV₁ (ml per second) and BMI divided into quintiles in subjects hospitalized for an acute exacerbation of COPD (AECOPD), with FEV₁ increasing as BMI category increased.
- BMI and lung function (non-adjusted) (six studies): Six studies (Dimov et al., 2013; Galesanu et al., 2014; Hallin et al., 2007; Lim et al., 2017; O'Donnell et al., 2011; Qiu et al., 2009) found BMI was positively associated with FEV₁ percentage predicted in analyses, unadjusted for confounding variables. BMI was positively correlated with FEV₁/FVC in two studies (O'Donnell et al., 2011; Qiu et al., 2009). Qui also found a higher BMI was also associated with a lower decline in lung function over time. Two studies (Galesanu et al., 2014; O'Donnell et al., 2011) found that BMI was not associated with FVC. O'Donnell found BMI was not associated with FVC percentage predicted. Galesanu found NS association between FEV₁ and BMI, while Lim found FEV₁ to be highest in subjects classified as OB by either the WHO or Asian-Pacific methods. BMI, FEV₁ was not reported in four studies (Dimov et al.; Hallin et al.; O'Donnell et al; Qiu et al).

Body weight and mortality outcomes

The majority of studies comparing BMI (kg/m²) between survivors and non-survivors with COPD found survivors had a significantly higher BMI. Among studies comparing mortality rates between BMI categories, a lower risk of mortality was found as BMI classification increased. Likewise, those in the lowest BMI groups had higher mortality rates when compared to those in higher BMI groups. In studies evaluating BMI as a predictor of mortality, those in the lowest BMI categories consistently showed higher mortality risk when compared to those in higher BMI classifications. While increasing body weight appeared to be protective when BMI was evaluated as a continuous variable, studies evaluating BMI as a categorical variable found that a BMI of approximately 25.0 to 29.99 had a lower risk of mortality, when compared to both higher and lower BMI classifications.

- BMI (mean ±SD) between survivors and non-survivors (five studies): Five studies evaluated the difference in BMI between survivors and non-survivors with COPD. Four studies (Hallin et al., 2007; Marti et al., 2006; Ranieri et al., 2008; Tsmogianni et al., 2009) found significantly higher BMI in survivors vs. non-survivors. One study (Galesanu et al., 2014) found no differences in BMI between the groups.
- Differences in mortality rates between BMI categories (six studies): Two studies (Abston et al., 2017; Lainscak et al., 2011) classified the BMI as participants into quintiles or quartiles (respectively) and found a lower risk of mortality as BMI categorization increased. In three studies that were unadjusted for confounding variables (Koul et al., 2017; Pothirat et al., 2007; Uh et al., 2011), two studies found higher mortality in the lowest BMI groups (Koul, Pothirat). Koul found higher mortality two years after AECOPD in the lowest BMI group compared to the 23-24.9 Group. Pothirat found higher mortality in the lowest BMI group compared to the next higher group (both with severe COPD). Uh found NS differences in cumulative survival rate between all BMI groups. One study (Zapatero et al., 2013) found that the OB Group (using ICD-9 codes) had a 0.4% reduction in risk of mortality, compared to NW Group, after adjusting for possible confounders in patients hospitalized for AECOPD.
- BMI and weight status as a predictor of mortality (12 studies):
  - Five studies evaluated BMI (or percentage of reference weight) as a continuous variable as a predictor of mortality in subjects with COPD. Three studies (Galesanu et al., 2014; Ranieri et al., 2008; Schols et al., 2005) found BMI was a predictor of mortality in univariate analyses. Two studies (Jiang et al., 2017; Ranieri et al., 2008) reported BMI to be a predictor of mortality in adjusted multivariate analysis. A fourth study (Galesanu et al., 2014) found NS association between BMI and mortality in adjusted multivariate analysis. The fifth study (Slinde et al., 2005) that used percentage of reference weight did not find an association with mortality.
  - Seven studies evaluated BMI as a categorical variable as a predictor of mortality and adjusting for confounding variables (Hallin et al., 2007; Jiang et al., 2017; Marti et al., 2006; Piquet et al., 2013; Rutenberg et al., 2013; Tsmogianni et al., 2009; Yamauchi et al., 2014). Mortality risk was higher for subjects in the lowest BMI group (ranging from less than 18.5 to 25) when compared to higher BMI groups. Yamauchi found higher all-cause in-hospital mortality in the lowest BMI group and lower mortality in the higher BMI categories, compared to the 18.5-22.9 Group in an Asian population. Hallin found higher risk for two-year mortality after AECOPD in all BMI categories, compared to the 25-30 Group. Marti found higher risk for both all-cause and respiratory mortality in the lower BMI groups, compared to the
What effect does body weight have on lung function outcomes in adults with COPD?

What effect does body weight have on mortality outcomes in adults with COPD?

What association exists between energy intake (e.g., kcal per kg) and outcomes in adults with COPD?

Supporting Evidence


Froli L, Boe J. The energy intake that is needed for weight gain in COPD candidates for lung transplantation. COPD 2005; 2:405-10


Selvi EC, Saikumar P, Kumar N. How to evaluate the risk of malnutrition in patients with COPD?. Global Journal of Medical Research: F Diseases 2014; 14:21-25


the recommendations were drawn, use the hyperlinks in the COPD: Macronutrient Composition 2019
Recommendations Summary

Quick Links

Recommendations Summary

COPD: Macronutrient Composition 2019

Click here to see the explanation of recommendation ratings (Strong, Fair, Weak, Consensus, Insufficient Evidence) and labels (Imperative or Conditional). To see more detail on the evidence from which the following recommendations were drawn, use the hyperlinks in the Supporting Evidence Section below.

- References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process
- None.
- Chronic Obstructive Pulmonary Disease
- Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)

COPD: Macronutrient Composition (Percentage Distribution)

The RDN should individualize the macronutrient composition of the diet based on nutrition assessment. Limited evidence examined the impact of macronutrient distribution did not confirm an ideal percentage distribution of carbohydrates, protein and fat, or if macronutrient distribution should be different for adults with COPD.

Rating: Fair

Imperative

- Risks/Harms of Implementing This Recommendation

There are no potential risks or harms associated with the application of this recommendation.

- Conditions of Application

- Comorbid conditions such as cardiovascular disease, diabetes, etc. should be considered when individualizing the macronutrient distribution
- Lifestyle, financial barriers and personal preferences should be considered when individualizing the macronutrient distribution.

- Potential Costs Associated with Application

Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN.

- Recommendation Narrative
One negative-quality non-randomized trial (Tümer et al, 2009) was included in the evidence analysis supporting the recommendation. The study provided a comparison between COPD subjects’ post-acute exacerbation (N=30 men) who consumed ~1,800kcal (28% carbohydrate (CHO), 50% fat, 16% protein) and COPD controls who consumed ~1,800kcal (57% CHO, 30% fat, 16% protein). After 10 days, subjects showed an improvement in forced vital capacity (P=0.033) and tidal volume (P=0.002), and the change was not significant in the controls. Neither group experienced significant differences in forced expiratory volume in one second or vital capacity change after 10 days.

**Recommendation Strength Rationale**
- Conclusion statement supporting the recommendation is Grade III, Limited/Weak.
- One study (all men) of short duration.

**Minority Opinions**
None.

**Supporting Evidence**

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

**Does the macronutrient composition (percentage distribution) of the diet have an effect on outcomes in adults with COPD?**

**References**

**References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process**
None.

**Chronic Obstructive Pulmonary Disease**

**Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)**

**Quick Links**

**Recommendations Summary**

**COPD: Vitamin D Supplementation 2019**

Click here to see the explanation of recommendation ratings (Strong, Fair, Weak, Consensus, Insufficient Evidence) and labels (Imperative or Conditional). To see more detail on the evidence from which the following recommendations were drawn, use the hyperlinks in the Supporting Evidence Section below.

**Recommendation(s)**

**COPD: Vitamin D Supplementation for Serum 25(OH)D Levels 11ng to 29ng/ml or Lower**

If an adult with COPD has serum 25(OH)D levels 11ng to 29ng per ml, the RDN should consider vitamin D supplementation to optimize serum 25(OH)D status. Limited evidence of vitamin D supplementation in adults with COPD supports improved exacerbation outcomes in those with baseline serum 25(OH)D levels 10ng per ml or lower.

**Rating:** Fair

**Conditional**

**COPD: Vitamin D Supplementation for Serum 25(OH)D Levels 10ng/ml or Lower**

If an adult with COPD has serum 25(OH)D levels ≤10ng per ml, the RDN should advise vitamin D supplementation to optimize serum 25(OH)D status. While vitamin D is important for health, evidence indicates that vitamin D supplementation may or may not improve lung function or reduce exacerbations in adults with COPD who have baseline serum levels within this range. Evidence related to the effect of vitamin D supplementation on lung function and exacerbation outcomes yielded mixed findings and depended upon on dosing, dosing frequency and delivery routes, length of intervention and baseline serum 25(OH)D levels.

**Rating:** Fair

**Conditional**

**Risks/Harms of Implementing This Recommendation**

There are no potential risks or harms associated with the application of this recommendation.

**Conditions of Application**

- The recommendation **COPD: Vitamin D Supplementation for Serum 25(OH)D Levels 10ng per ml or Lower** applies to those with serum 25(OH)D levels ≤10ng per ml
- The recommendation **COPD: Vitamin D Supplementation for Serum 25(OH)D Levels 11ng to 29ng per ml** applies to those with serum 25(OH)D levels that are insufficient (21ng to 29ng per ml) or deficient (less than 20ng per ml).
- Coordination with the prescribing provider may be required for vitamin D supplement orders.
- Achievement of normal serum 25(OH)D levels may not be possible in all instances. Therefore, optimizing serum 25(OH)D levels is the goal (Rusinska et al, 2018).

**Potential Costs Associated with Application**

- Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN.
- Costs may be incurred related to the purchase of over-the-counter vitamin D supplements or co-pays.

**Recommendation Narrative**

A total of eight studies were included in the evidence analysis supporting the recommendations:

- Six randomized controlled trials (RCTs) (four positive-quality (Lehouck et al, 2012; Martineau et al, 2015; Rafiq et al, 2017; Sanjari et al, 2016), one neutral-quality (Khan et al, 2017) and one negative-quality (Zendendel et al, 2015)).
- Two before-after studies (both neutral-quality (Rezk et al, 2015; Said and Abd-Elnaeem, 2015)).

Seven studies tested oral vitamin D₃ (cholecalciferol) ranging from 1,200 IU daily for six months; subjects and controls could also take 400 IU vitamin D₃ daily (Rafiq et al, 2017) to 120,000 IU every two months for 12 months (Martineau et al, 2015).
- One study administered 200,000 IU cholecalciferol intramuscularly (IM) every four weeks for six months (Said and Abd-Elnaeem, 2015).
- All papers either cited the Endocrine Society Clinical Practice Guideline (ESG) (Holick et al, 2011) for serum 25(OH)D classifications or did not define classifications. In addition to the ESG reference, one study (Lehouck et al, 2012) defined “severe” vitamin D deficiency as serum 25(OH)D levels under 10ng per ml.

None.
Seven studies evaluated lung function (LF) outcomes (Lehouch et al 2012; Martineau et al. 2015; Rafiq, et al. 2017; Rezk et al. 2015; Sanjai et al. 2016; Said and Abd-Elnaeem, 2015; Zendedel et al. 2015). Six studies evaluated acute exacerbation (AE) outcomes (Khan et al. 2017; Lehouch et al. 2012; Martineau et al. 2015; Rafiq et al. 2017; Rezk et al. 2015; Zendedel et al. 2015).

Five studies of vitamin D supplementation included subjects' pre- and post-supplementation levels, allowing changes in vitamin D status due to supplementation to be assessed. Results according to baseline (BL) and post-supplementation improvements in vitamin D status (ESG categories) are as follows:

- **Deficient to sufficient 25(OH)D:** Supplementation with 1, 200 IU D₃ daily for six months (plus 400 IU daily, if desired) resulted in no impact on LF or AE outcomes (Rafiq et al. 2012). Supplementations with 100, 000 IU D₃ every four weeks over 12 months resulted in a decrease in AE rate in a sub-group of subjects with "severe deficiency" (25(OH)D under 10 ng per ml (Lehouch et al. 2012).
- **Insufficient to sufficient 25(OH)D:** Supplementation with 100, 000 IU D₃ every four weeks over 12 months resulted in no impact on AE or LF outcomes (Lehouch et al. 2012). Supplementation with either 5, 000 IU D₃ or 0.25mg calcium every four weeks over 12 months resulted in no impact on LF outcomes (Sanjai et al. 2016).
- **Deficient to insufficient 25(OH)D:** Supplementation with 50, 000 IU D₃ per week for eight weeks, then 800 IU daily for 12 months resulted in a decrease in number of AEs and an improvement in MVV, but no impact on other LF outcomes in subjects with 25(OH)D under 10ng per ml at BL (Rezk et al. 2015). Supplementations with 120, 000 IU D₃ every two months over 12 months resulted in improvement in AE severity and symptoms, but had no impact on other AE or LF outcomes (Martineau et al. 2015).

The remaining three studies did not report subjects' pre-supplementation vitamin D status. One study (Said and Abd-Elnaeem, 2015) reported BL vitamin D status according to ESG categories, but did not report post-supplementation status. The second study (Khan et al. 2017) reported BL vitamin D status and controls combined and did not report pre- and post-supplementation status of subjects only. Finally, the last study (Zendedel et al. 2015) did not report either BL or post-supplementation vitamin D status.

- **Insufficient 25(OH)D (subjects + controls):** Supplementation with 2, 000 IU D₃ per day for six months resulted in reduced AEs (Kahn et al. 2017). Supplementations with 200, 000 IU D₃ IM every four weeks for six months resulted in no impact in LF outcomes (Said and Abd-Elnaeem, 2015).
- **Unknown 25(OH)D:** Supplementation with 100, 000 IU D₃ every month for six months resulted in improvement in LF outcomes and a reduction in AEs (Zendedel et al. 2015).

### Recommendation Strength Rationale

- Conclusion statements supporting the recommendations are Grade II, Fair
- Synthesis of the results was challenging due to lack of consistency in vitamin D dosing, dosage frequency and delivery routes, length of intervention and baseline serum 25(OH)D levels.

### Minority Opinions

None.

### Supporting Evidence

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below [recommendations rated consensus will not have supporting evidence linked].

**Does vitamin D supplementation improve lung function and exacerbation outcomes in adults with COPD?**

**References**


### References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process


### Chronic Obstructive Pulmonary Disease

### Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)

### Recommendations Summary

**COPD: Monitor and Evaluate Energy Intake and Body Weight for Energy Needs 2019**

**Copyright Academy of Nutrition and Dietetics (A.N.D), Evidence Analysis Library. Printed on: 09/04/19 Page 14**
COPD: Monitor and Evaluate Energy Intake and Body Weight for Energy Needs

For adults with COPD, the RDN should routinely monitor and evaluate body weight (BW) status and energy intake and adjust the estimated calorie prescription to achieve or maintain an optimal weight. Evidence suggests an association between BW status and both mortality and lung function in adults with COPD. Strong evidence indicates that the lowest BMI groups had higher mortality rates when compared to higher BMI groups. Furthermore, a BMI classification of approximately 25.0kg/m² to 29.99kg/m² appeared to lower risk of mortality when compared to both higher and lower BMI classifications. In unadjusted results, fair evidence indicates that BMI was positively associated with FEV₁ percentage predicted. Fair evidence was also found showing improvement in dyspnea scores with higher energy intakes.

Rating: Fair

Recommendation(s)

1. An optimal body weight goal should be individualized for each patient.
2. There is no potential risk or harm associated with the application of this recommendation.

Rating: Imperative

Risks/Harms of Implementing This Recommendation

There are no potential risks or harms associated with the application of this recommendation.

Conditions of Application

- Over time, the monitoring of BW against energy intake is probably the most meaningful expression of energy requirement in COPD. If adverse changes in body weight or composition are occurring, equal attention should be paid to the possibility that the patient is not consuming the target intake or that the target intake is not correct.
- An optimal body weight goal should be individualized for each patient.

Potential/Costs Associated with Application

Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN.

Recommendation Narrative

Energy Intake

A total of nine studies were included in the evidence analysis supporting the recommendation:

- Four randomized controlled trials: One positive-quality (Sugawara et al, 2012), three neutral-quality (Forlì and Boe, 2005; Planas et al, 2005; Weekes et al, 2009).
- Five cross-sectional studies: Three neutral-quality (Lee et al, 2013; Renvall et al, 2009; Yazdanpanah et al, 2010) and two negative-quality (Benton et al, 2010; Selvi et al, 2014).

There was improvement in dyspnea scores with higher energy intakes, with less robust evidence supporting a beneficial relationship with functional status, healthcare utilization or duration of illness.

- Respiratory symptoms (three studies): All three studies found significant associations with dyspnea scores (Lee et al, 2013; Sugawara et al, 2012; Weekes et al, 2009).
- Functional status (one study): The study found a significant association with activities of daily living scores (Weekes et al, 2009).
- Healthcare utilization (one study): The study found a significant association with number of infections requiring antibiotics (Forlì and Boe, 2009).
- Duration of illness (one study): The study found a significant association with duration of disease in years (Selvi et al, 2014).

The findings for the impact of energy intake on exacerbations, quality of life (QoL), weight status and body composition were mixed, with the majority supportive of an association.

- Exacerbations (two studies): One study found a significant association with number of emergency room (ER) visits due to acute exacerbations (AEs) (Lee et al, 2013). One study did not find a association with number of ER visits due to AEs with energy intakes of either 1.7x or 1.3x Harris-Benedict Equation (HBE) (Planas et al, 2005).
- QoL (three studies): All three studies found significant associations of Chronic Respiratory Disease Questionnaire (CRQ) scores with energy intakes of 1.3 x HBE (Planas et al, 2005), CRQ scores (Sugawara et al, 2012) and St. George Respiratory Quotient (SGRQ) scores (Weekes et al, 2009). One study did not find significant associations for CRQ scores with energy intakes of 1.7 x HBE (Planas et al, 2005).
- Weight status (seven studies)
  - Six studies found significant associations
    - Weight gain with energy intakes of 1.7 x HBE (Planas et al, 2005)
    - Percentage IBW (Sugawara et al, 2012)
    - Weight gain (Forlì and Boe, 2005; Sugawara et al, 2012; Weekes et al, 2009)
  - Two studies did not find associations
    - BMI (Benton et al, 2010)
    - BW with energy intakes of 1.3 x HBE (Planas et al, 2005).
- Body composition (three studies): All three studies found significant associations with fat mass (FM), triceps skinfold (TSF) and fat-free mass index (FFMI) with energy intakes of 1.7 x HBE (Planas et al, 2005), FM, fat mass index (Sugawara et al, 2012) and mid-arm circumference and sum of four skinfold thickness measurements (Weekes et al, 2009). All three studies also did not find associations with mid-arm muscle circumference (Weekes et al, 2009), FMFI and arm circumference (Sugawara et al, 2012) or FM, TSF and FMFI with energy intakes of 1.3 x HBE (Planas et al, 2005).

The evidence for a relationship between energy intake and lung function, systemic inflammation or exercise capacity was inconsistent.

- Lung function (five studies): Two studies found significant associations in forced vital capacity (FVC) and sniff pressure (Weekes et al, 2009) and Pmax inspiratory (Planas et al, 2012). Three studies did not find associations in FEV₁ in one second (FEV₁) (Lee et al, 2013; Yazdanpanah et al, 2010), FEV₁ with energy intakes of either 1.7 x or 1.3 x HBE (Planas et al, 2005), FVC, FEV₁,FVC and vital capacity (Yazdanpanah et al, 2010), Pmax and Pmax expiratory (PEmax) (Weekes et al, 2009) or PEmax (Sugawara et al, 2012).
- Systemic inflammation (one study): The study found a significant association with IL-6, but not CRP (Sugawara et al, 2012).
- Exercise capacity (five studies): Three studies found significant associations with upper and lower body strength (Benton et al, 2010) and six-minute walking distance (Benton et al, 2010; Lee et al, 2013; Sugawara et al, 2012). Two studies did not find associations: Handgrip strength (HGS) with energy intakes of either 1.7 x or 1.3 x HBE (Planas et al, 2005) and HGS (Weekes et al, 2009).

* For Sugawara et al, 2012, the workgroup considered the between-group analysis only in the conclusion statement.

Energy Needs

A total of five studies were included in the evidence analysis supporting the recommendation:

- Three cross-sectional studies: One positive-quality (Sindel et al, 2011), one neutral-quality (Faroq et al, 2015), one negative-quality (Ramos et al, 2016).
- Two diagnostic, validity or reliability studies: Both neutral-quality (Nordenson et al, 2010; Sindel et al, 2008).

Predictive equations for estimating RMR: A total of 11 equations were tested for validity in predicting RMR in adults with COPD. Two of these [Moore & Angelio (MACE), Nordenson] were equations developed specifically for COPD patients, while the other equations were developed for healthy adults [Harris-Benedict (HBE), Mifflin St. Jeor (MSJE), Westerterp, de Oliveira, Owen and four variations of Food and Agriculture Organization of the United Nations/World Health Organization/United Nations University (FAO/WHO/UNU)], which were WHO (including height), WHO (omitting height), Nordic Nutrition Recommendation (NNRE) and the Schofield equation. In two of the studies (Faroq et al, 2015; Sindel et al, 2011) these equations were evaluated as a starting point for total energy expenditure (TEE).

- Accuracy: Four of the 11 equations for predicting RMR were tested for accuracy, but only in one study (Sindel et al, 2008). Sindel found that the Westerterp equation yielded an accuracy rate of 68%, followed by the WHO (including height) equation (63%) and HBE (61%). The MAE had the lowest accuracy rate (51%).
Body weight and lung function outcomes

All studies using FEV$_1$, percent predicted as an outcome found a positive association with BMI or BMI category and one longitudinal study showing increasing BMI reduced declines in FEV$_1$ percent predicted over time. While these studies appear to indicate that increasing BMI is associated with improvements in FEV$_1$, percent predicted, results did not include adjustment for relevant confounders and should be interpreted with caution. Results for other lung function measures (FEV$_2$, FVC, FVC percentage predicted, FEV$_1$/FVC) were mixed and therefore, no conclusion can be drawn for these measures.

- FEV$_1$ stratified into quintiles and BMI (one study): Six studies (Farooqi et al, 2015) found BMI was not associated with FEV$_1$ in the overall group or in any of the FEV$_1$ quintiles. In each of the FEV$_1$ quintiles, FEV$_1$ percent predicted showed inverse associations with BMI, while FEV$_2$/FVC showed a positive association with BMI.
- BMI stratified into quintiles and FEV$_1$ (one study): One study (Lainscak et al, 2011) found a positive association between BMI and FEV$_1$. Among studies comparing mortality with BMI, one study (Abston et al, 2017) found higher mortality in the lowest BMI categories, compared to the 23-24.9 Group. Pothirat found higher mortality in the lowest BMI group compared to the next higher group (both with BMI ranging from under 18.5 to 25). Two studies (Koul et al, 2019; Jiang et al, 2021) found higher mortality in the lowest BMI group compared to higher BMI categories. While increasing body weight appeared to be protective when BMI was evaluated as a continuous variable, studies evaluating BMI as a categorical variable found that a BMI of approximately 25.0 to 29.9 had a lower risk of mortality when compared to both higher and lower BMI classifications.

- BMI (mean ±SD) between survivors and non-survivors (five studies): Five studies evaluated the difference in BMI between survivors and non-survivors with COPD. Four studies (Hahn et al, 2007; Mani et al, 2006; Raineri et al, 2008; Tsimogianni et al, 2009) reported BMI was a predictor of mortality in subjects with COPD. Among studies evaluating BMI as a predictor of mortality, those in the lowest BMI categories consistently showed higher mortality risk compared to those in higher BMI classifications. While increasing body weight appeared to be protective when BMI was evaluated as a continuous variable, studies evaluating BMI as a categorical variable found that a BMI of approximately 25.0 to 29.9 had a lower risk of mortality when compared to both higher and lower BMI classifications.

- BMI and weight status as a predictor of mortality (12 studies):
  - Five studies evaluated BMI (percentage reference weight) as a continuous variable as a predictor of mortality in subjects with COPD. Three studies (Galesanu et al, 2014; Raineri et al, 2008; Schols et al, 2005) found BMI was a predictor of mortality in univariate analyses. Two studies (Jiang et al, 2017; Raineri et al, 2008) reported BMI was a predictor of mortality in adjusted multivariate analysis. A fourth study (Galesanu et al, 2014) found NS association between BMI and mortality in adjusted multivariate analysis. The fifth study (Sindle et al, 2008) that used percentage reference weight did not find an association with mortality.
  - Seven studies evaluated BMI as a categorical variable as a predictor of mortality and adjusting for confounding variables (Hahn et al, 2007; Jiang et al, 2017; Mani et al, 2006; Piquet et al, 2013; Ruten et al, 2013; Tsimogianni et al, 2009; Yamauchi et al, 2014). Mortality risk was higher for subjects in the lowest BMI group (ranging from under 18.5 to 25) when compared to higher BMI groups. Yamachi found higher all-cause in-hospital mortality in the lowest BMI group and lower in the higher BMI categories, compared to the 18.5-22.9 Group in an Asian population. Hallin found higher risk for two-year mortality after AECOPD in the lowest BMI group compared to the next higher group (both with BMI ranging from under 18.5 to 25). Pothirat found higher risk for mortality 48 months after AECOPD in the highest BMI categories. Ruten found the highest two- and three-year survival in subjects in BMI categories 25 to 29.99 compared to lower groups as well as those above 30. Jiang found a higher risk of mortality as BMI group classification decreased. Tsimogianni found that a BMI group of less than 25 had a higher risk of three-year mortality.
What effect does body weight have on mortality outcomes in adults with COPD?

What association exists between energy intake (e.g., kcal per kg) and outcomes in adults with COPD?

OVERALL: If measurements are not available, what are the best methods to predict energy needs in adults with COPD?

- **Minority Opinions**
  
  None.

- **Supporting Evidence**
  
  The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

  **What effect does body weight have on mortality outcomes in adults with COPD?**

  **What association exists between energy intake (e.g., kcal per kg) and outcomes in adults with COPD?**

  **OVERALL: If measurements are not available, what are the best methods to predict energy needs in adults with COPD?**

  **References**


References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process
None.

**Chronic Obstructive Pulmonary Disease**
**Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)**

### Quick Links

#### Recommendations Summary

**COPD: Monitor and Evaluate Serum 25(OH)D Status 2019**

[Click here](#) to see the explanation of recommendation ratings (Strong, Fair, Weak, Consensus, Insufficient Evidence) and labels (Imperative or Conditional). To see more detail on the evidence from which the following recommendations were drawn, use the hyperlinks in the **Supporting Evidence Section** below.

- **Recommendation(s)**
  - **COPD: Monitor and Evaluate Serum 25(OH)D Levels**
  
  The RDN should periodically check serum 25(OH)D levels in adults with COPD as part of a routine nutrition monitoring and evaluation. Evidence from 60% of studies reviewed found positive associations between serum 25(OH)D and lung function measures.
  
  **Rating:** Fair
  
  **Imperative**

  - **Risks/Harms of Implementing This Recommendation**
    - There are no potential risks or harms associated with the application of this recommendation.

  - **Conditions of Application**
    - If necessary data are not available, the RDN should use professional judgment to request or obtain additional data.

  - **Potential Costs Associated with Application**
    - Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN
    - Costs may be incurred due to lab testing to evaluate serum 25(OH)D levels.

  - **Recommendation Narrative**
    - A total of 29 papers from 28 studies provided evidence supporting the recommendation.
      - Four retrospective cohort studies: Three positive-quality (Berg et al, 2013; Malinovschi et al, 2014; Mekov et al, 2016) and one neutral-quality (Moberg et al, 2014).
      - Two randomized controlled trials (RCT): One positive-quality (Sanjari et al, 2016) and one neutral-quality (Yumrutepe et al, 2015).
      - One neutral-quality before-after study (Said and Abd-Einaeem, 2015).
      - One neutral-quality descriptive study (Gouda et al, 2016).
      - One neutral-quality case-control study (Kunisaki et al, 2011).
    
    The overall findings were as follows:
      - **Mortality**: Five studies: NS relationships were found in any of the studies (Holmgaard et al, 2015; Mekov et al, 2016; Moberg et al, 2014; Persson et al, 2015; Puhan et al, 2015)
Recommendation Strength Rationale
- Conclusion statement supporting the recommendation is Grade II, Fair.
- Synthesis of results was challenging due to lack of consistency in vitamin D dosing, dosing frequency and delivery routes, length of intervention and baseline serum 25(OH)D levels.

Minority Opinions
None.

Supporting Evidence
The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

What associations exist between serum 25(OH)D levels and mortality, lung function and exacerbation outcomes in adults with COPD?

References
- Bassem I, El-Shafey and Hesham A, El-Soufy B. Does serum 25 hydroxy vitamin D level play a role in COPD?. Egyptian Journal of Chest Diseases and Tuberculosis 2014; 63:43-47
- Kunisaki K, Newcomer D, Singh R, Conno J. Vitamin D status and longitudinal lung function decline in the Lung Health Study. The European Respiratory Journal 2011; 37:238-43
COPD: Monitor and Evaluate Effect of Vitamin D Supplementation 2019

**Recommendations Summary**

**COPD: Monitor and Evaluate Effect of Vitamin D Supplementation**

In adults with COPD who are receiving vitamin D supplementation, the RDN should monitor and evaluate the effect of the supplementation regimen on serum 25(OH)D levels. If baseline serum 25(OH)D levels were ≤10ng per ml, the RDN should also evaluate the frequency of exacerbations to measure the effectiveness of supplementation. Limited evidence of increased inhaled or systemic steroids. Achievement of normal serum 25(OH)D levels may not be possible in all instances. Therefore, optimizing serum 25(OH)D levels is the goal (Rusinska et al., 2018).

**Rating:** Fair

**Conditions of Application**

- The recommendation applies to adults with COPD with baseline (BL) serum 25(OH)D levels ≤10ng per ml who may also have frequent exacerbations. Frequent exacerbations are defined as two or more exacerbations per year (Hurst et al., 2010; Le Rouzi et al., 2018).
- Coordinating with the prescribing provider may be required for recommended changes to vitamin D supplementation and physician orders.
- Exacerbations are clinically defined as episodes of increasing respiratory symptoms, particularly dyspnea, cough and sputum production and increased sputum purulence (Wedzicha et al., 2017). The patient perception of an exacerbation is seeking treatment for symptoms; the research criteria is treatment with antibiotics or addition of increased inhaled or systemic steroids.

**Potential Costs Associated with Application**

- Costs may include expenses related to medical nutrition therapy (MNT) visits from an RDN
- Costs may be incurred related to the purchase of over-the-counter vitamin D supplements or co-pays
- Costs may be incurred due to lab testing to evaluate serum 25(OH)D levels.

**Recommendation Narrative**

A total of eight studies were included in the evidence analysis supporting the recommendation:

- Six randomized controlled trials (RCTs) (four positive-quality (Lehouck et al., 2012; Martineau et al., 2015; Rafiq et al., 2017; Sanjari et al., 2016), one neutral-quality (Khan et al., 2017) and one negative-quality (Zendelend et al., 2015))
- Two before-after studies (both neutral-quality (Rezk et al., 2015; Said and Abd-Elnaeem, 2015)).

Seven studies tested oral vitamin D₃ (cholecalciferol) ranging from 1, 200 IU daily for six months; subjects and controls could also take 400 IU vitamin D₃ daily (Rafiq et al., 2017) to 120, 000 IU every two months for 12 months (Martineau et al., 2015).

- One study administered 200, 000 IU cholecalciferol intramuscularly (IM) every four weeks for six months (Said and Abd-Elnaeem, 2015).
- All papers either cited the Endocrine Society Clinical Practice Guideline (ESG) (Holick et al., 2011) for serum 25(OH)D classifications or did not define classifications.

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**References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process**


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**Chronic Obstructive Pulmonary Disease**

**Chronic Obstructive Pulmonary Disease (COPD) Guideline (2019)**

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**Quick Links**

Five studies of vitamin D supplementation included subjects’ pre- and post-supplementation levels, allowing changes in vitamin D status due to supplementation to be assessed. Results according to baseline (BL) and post-supplementation improvements in vitamin D status (ESG categories) are as follows:

- **Deficient to sufficient 25(OH)D:** Supplementation with 2, 000 IU D₃ daily for six months (plus 400 IU daily, if desired) resulted in no impact on LF or AE outcomes (Rafiq et al, 2012). Supplementation with 100, 000 IU D₃ every four weeks over 12 months resulted in a decrease in AE rate in a sub-group of subjects with “severe deficiency” [25(OH)D under 10ng per ml] (Lehouck et al, 2012).
- **Insufficient to sufficient 25(OH)D:** Supplementation with 100, 000 IU D₃ every four weeks over 12 months resulted in no impact on AE or LF outcomes (Lehouck et al, 2012). Supplementation with either 5, 000 IU D₃ or 0.25mg calcitriol every four weeks over 12 months resulted in no impact on LF outcomes (Sanjani et al, 2016).
- **Deficient to insufficient 25(OH)D:** Supplementation with 50, 000 IU D₃ per week for eight weeks, then 800 IU daily for 12 months resulted in a decrease in number of AEs and an improvement in MVV, but no impact on other LF outcomes in subjects with 25(OH)D under 10ng per ml at BL (Rezk et al, 2015). Supplementation with 120, 000 IU D₃ every two months over 12 months resulted in improvement in AE severity and symptoms, but had no impact on other AE or LF outcomes (Martineau et al, 2015).

The remaining three studies did not report subjects’ post-supplementation vitamin D status. One study (Said and Abd-ElNaeem, 2015) reported BL vitamin D status according to ESG categories, but did not report post-supplementation vitamin D status. The second study (Khan et al, 2017) reported BL vitamin D status of subjects and controls combined and did not report pre- and post-supplementation status of subjects only. Finally, the last study (Zendedel et al, 2015) did not report either BL or post-supplementation vitamin D status.

- **Insufficient 25(OH)D (subjects + controls):** Supplementation with 2, 000 IU D₃ per day for six months resulted in reduced AEs (Kahn et al, 2017). Supplementation with 200, 000 IU D₃/IM every four weeks for six months resulted in no impact in LF outcomes (Said and Abd-ElNaeem, 2015).
- **Unknown 25(OH)D:** Supplementation with 100, 000 IU D₃ every month for six months resulted in improvement in LF outcomes and a reduction in AEs (Zendedel et al, 2015).

### Recommendation Strength Rationale

- Conclusion statement supporting the recommendation is Grade II, Fair
- Synthesis of results was challenged due to lack of consistency in vitamin D dosing, dosing frequency and delivery routes, length of intervention and baseline serum 25(OH)D levels.

### Minority Opinions

None.

### Supporting Evidence

The recommendations were created from the evidence analysis on the following questions. To see detail of the evidence analysis, click the blue hyperlinks below (recommendations rated consensus will not have supporting evidence linked).

**Does vitamin D supplementation improve lung function and exacerbation outcomes in adults with COPD?**

### References


### References not graded in Academy of Nutrition and Dietetics Evidence Analysis Process