

**The influence of deprivation on malnutrition risk in outpatients
with chronic obstructive pulmonary disease (COPD)**

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Title: The influence of deprivation on malnutrition risk in outpatients with chronic obstructive pulmonary disease (COPD).

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Short title: Deprivation and malnutrition risk in COPD

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Abstract (250/250 inclusive of titles)

Background & Aims

The social gradient in chronic obstructive pulmonary disease (COPD) is considerable, but the influence of deprivation on common clinical risk factors such as malnutrition is unclear. This study aimed to explore the relationship between COPD disease-severity, deprivation and malnutrition.

Methods

424 outpatients with a confirmed diagnosis of COPD were routinely screened for malnutrition risk using the 'Malnutrition Universal Screening Tool' ('MUST') while attending respiratory clinics across two hospitals; a large city hospital (site A) and a smaller community hospital (site B). Deprivation was assessed for each outpatient according to their address (postcode) using the English governments' index of multiple deprivation (IMD) and related to malnutrition risk. Each postcode was attributed to both an IMD score and IMD rank, where a higher IMD score and a lower IMD ranking indicated increased deprivation.

Results

Overall prevalence of malnutrition was 22% (95% CI 18 -26%; 9% medium risk, 13% high risk). It was significantly higher at site A (28% vs. 17%; $p = 0.004$) where patients were also significantly more likely to reside in areas of more deprivation than those at site B (IMD rank: 15,510 SD 8137 vs. 22,877 SD 6827; $p < 0.001$). COPD disease-severity was positively associated with malnutrition ($p < 0.001$) whilst a higher rank IMD was negatively associated with malnutrition ($p = 0.014$).

Conclusions

Deprivation is a significant independent risk factor for malnutrition in outpatients with COPD. Consideration of deprivation is important in the identification of malnutrition and the nutritional management of patients with COPD.

Key words: malnutrition, deprivation, COPD, 'MUST'

Introduction (479/450, 1.5 pages)

The differences in health experienced by deprived individuals or population groups and those living in more affluent areas is considerable and arguably increasing. This is despite consecutive government policies seeking to reduce the health inequalities associated with poor health. The impact of social inequalities on individual and population health has been of interest for over a century and recently The Marmot Review in England highlighted they can make the difference between life and death, health and sickness, well-being and misery [1]. The review highlighted that people experience avoidable differences in health and that the lower social classes experience markedly higher mortality and morbidity. Individuals, families or groups are considered to be in poverty, if they are unable to acquire the necessary diets, to participate in physical activities, and to live in the environments that are encouraged by their societies [2].

Despite the negative association between deprivation and health, research exploring its impact on malnutrition risk is limited, although one study involving a heterogeneous group of elderly inpatients reported deprivation to be significantly and independently associated with in-hospital mortality [3]. In this observational study, patient's deprivation was assessed using the English Index of Multiple Deprivation (IMD). Patients that were identified as at risk of malnutrition using the 'Malnutrition Universal Screening Tool', 'MUST [4], were significantly more likely to reside in an area of deprivation in comparison to those inpatients assessed as not being at risk of malnutrition. The IMD identifies the most deprived areas across England and aims to establish the deprivation experienced by individuals living at the local level (postcode). A single deprivation score or rank is produced through the combination of several indicators of deprivation such as economic, social, education and housing issues [5].

In the urban and deprived areas of England diseases such as chronic obstructive pulmonary disease (COPD) have been found to be more common. In addition, the mortality associated with such chronic diseases has also been

found to be higher in areas of deprivation. These social inequalities relating to health are also associated with increased hospitalisation secondary to respiratory infections [6]. The magnitude of this association is highlighted by the observation that there is a 14 times greater risk of death from COPD among working aged men employed in unskilled manual work than in their counterparts employed in skilled professions [7]. In addition, the prevalence of malnutrition in COPD outpatients is high with up to 45% of outpatients said to be at risk [8]. Therefore, it is possible that a combination of deprivation and malnutrition drives poor clinical outcomes in patients with COPD, and consideration of this could assist in targeting nutritional interventions in this patient group. The relationship between deprivation and malnutrition risk in COPD has not been previously explored. Therefore, this research sought to explore the extent to which deprivation is related to malnutrition, taking into account the effects of disease severity.

Methods

Consecutive outpatients with COPD attending respiratory clinics with a confirmed diagnosis of COPD were prospectively enrolled into the study and screened for malnutrition using the 'Malnutrition Universal Screening Tool' ('MUST') [4]. 424 outpatients were routinely screened for malnutrition risk by trained respiratory nurse specialists across two hospitals; a large university city hospital (site A; Southampton General Hospital) and a smaller community hospital in a more rural area (site B; Lymington New Forest Hospital). Any duplicate malnutrition risk screening records were removed resulting in the final sample. Outpatients were classified as being either at risk of malnutrition (medium or high risk category) or not at risk (low risk category) according to 'MUST'. To explore the relationship between deprivation and malnutrition, the postcode was used to identify the geographical location of residence of individual patients so that it could be assigned a deprivation risk using the English IMD [5]. Based upon the patient's postcode the IMD produces both a score and a rank. For IMD scores, individuals residing within a particular postcode were more likely to experience greater deprivation the higher the IMD score. However, because the score is weighted and has an exponential distribution it is not possible to say a postcode with an IMD score of 20 is

twice as deprived as one with a score of 10. In order to make comparisons between postcodes it is recommended that ranks be used. In England, for 32,482 geographic areas, the ranking order according to IMD ranges from 1, to indicate the most deprived area, to 32,484, to indicate the least deprived area. Therefore, a higher IMD rank indicates lower deprivation is likely to be experienced by those individuals for the IMD components (deprivation domains) such as income, employment, living environment and health and disability. The IMD score or rank for each outpatient's postcode allowed estimation of deprivation for small residential areas. In addition to exploration of the relationship between malnutrition and deprivation, the influence of the individual components of IMD was also assessed.

Demographic data were collected from electronic hospital records and severity of COPD was classified using the GOLD criteria (Global Initiative for Management of Obstructive Lung Disease) [9]. Associations between malnutrition risk, COPD disease-severity and deprivation were assessed using SPSS statistical software package version 23.0 (Chicago, IL) and a variety of tests, including ANOVA to compare differences between continuous variables, Chi-square analysis to compare differences between categorical variables, and binary logistic regression to assess the association between malnutrition risk and other variables including deprivation. A p value of < 0.05 was considered to be significant. Ethical approval was granted by Southampton and South West Hampshire Ethics (07/Q1702/70) and Southampton University Hospital NHS Foundation Trust (ELIA002) and formed part of a larger randomised trial that explored deprivation and mortality as well as nutritional support in COPD (Clinical trials identifier: NCT00538200).

Results

For the study population as a whole the mean IMD score for the cohort was 15.9 SD 11.1 (range 1.88 to 57.05) and the mean IMD rank for outpatients was 19,576 SD 8,289 (range 1,226 to 32,300). There was a significant difference in mean deprivation scores and ranks between the hospital sites. Deprivation was greater among COPD outpatients attending the larger city

hospital (site A) than the smaller rural hospital (site B) when assessed using both the IMD score (21.3 vs 11.6 for the respective sites; $p < 0.001$) and IMD rank (15,510 vs 22,877; $p < 0.001$ (Table 1)). The prevalence of malnutrition risk (medium + high risk) amongst the COPD outpatients also significantly differed between the two hospital sites (site A; 28% versus site B; 17%, $p = 0.004$ Chi-square test). Deprivation and malnutrition prevalence were the only characteristics that were significantly different between the two sites, with no differences in the severity of COPD ($p = 0.450$ Chi-square test) or smoking status ($p = 0.549$), age, gender distribution and body mass index (**Table 1**).

Malnutrition risk was present in 22% of outpatients (95% CI 18 -26%; 9% medium risk, 13% high risk). Outpatients identified as being at risk were significantly more likely to reside in an area associated with increased deprivation than those not at risk of malnutrition, both when assessed using the IMD score (IMD 18.3 versus 15.2; $p = 0.018$ by ANOVA) and the IMD rank; OR (per unit increase of IMD) 1.024, 95% CI 1.004 - 1.044) and the IMD rank (low risk: 20,147 vs medium + high risk: 17,454; $p = 0.007$). In addition to malnutrition risk being significantly associated with overall deprivation, it was also associated with a number of the deprivation domains, including health and disability ($p = 0.002$), education skills and training ($p = 0.006$), crime ($p = 0.010$) and living environment ($p = 0.003$) (**Table 2**). However, COPD severity was also found to be associated with malnutrition risk (moderate COPD: 11.1%; severe COPD: 17.0%; very severe COPD: 35.9%, according to the GOLD classification $p < 0.001$ Pearson Chi-squared). In addition, smoking status was also significantly associated with malnutrition risk (not currently smoking (ex-smoker/never smoked) vs currently smoking: 19.4% vs 32.1% respectively; $p = 0.014$, Pearson Chi-square) and deprivation ($p < 0.001$ for both IMD score (14.8 ± 10.4 vs 20.4 ± 12.9) and IMD rank $\times 0.001$ (20.4 ± 8.0 vs 16.3 ± 8.7)). There was no significant relationship between malnutrition risk according to 'MUST' and mean age (low risk: 73 SD 10 years versus medium + high risk: 73 SD 11 years; $p = 0.941$ ANOVA). However, when outpatients were categorised according to three age categories, significant trends were observed with the mean IMD rank increasing significantly with each age category (<65 years: 17,622 SD 8,242; 65 – 74.9 years: 19,121 SD 8,290; \geq

75 years: 20,768; $p(\text{trend}) = 0.008$ ANOVA). This indicates a significant reduction in likely deprivation with age in the current cohort.

Using binary logistic regression, IMD rank remained a significant explanatory variable for malnutrition risk (OR 0.969 (95% CI, 0.939-0.999); $p = 0.046$) after adjustment for COPD disease severity, current smoking status (both of which were found to be significant independent explanatory variables; $p < 0.001$ and $p = 0.024$ respectively) and age. Several of the individual domains of deprivation (health deprivation and disability, barriers to housing, crime, and living environment) also remained significant after adjustment for the same variables, irrespective of whether the binary logistic regression was carried out using IMD score or rank as the dependent variable (**Table 3**). Without adjustments for smoking the associations were more significant (e.g. for rank IMD, $p = 0.014$; rank health and disability ($p = 0.008$); rank barriers to housing $p = 0.022$; rank crime, $p = 0.014$; and rank living environment, $p = 0.022$). Modelling of data using binary logistic regression allowed analysis of malnutrition risk according to COPD disease-severity and rank IMD (**Figure 1**).

Discussion

The current findings are the first to show that deprivation measured with the English index of multiple deprivation, is an independent explanatory variable for malnutrition in COPD outpatients. These findings complement those of a previous study involving a heterogeneous cohort of hospitalised patients which found deprivation based on IMD to independently predict malnutrition risk and in-hospital mortality [3]. The more specific findings of the present study, involving only patients with COPD in England are of particular clinical relevance to the National Health Service when it is under considerable economic and operational pressure. Deprivation has been previously found to be associated with hospitalisation of both COPD [10] and cardiology patients [11]. In the case of COPD, a strong independent association was found between deprivation and the time to the first hospitalisation due to an acute exacerbation of COPD [12]. This suggests that consideration of deprivation could assist in ensuring both clinical and cost effective allocation of resources.

Despite the high prevalence of malnutrition in this patient group, respiratory clinics may not have ready access to outpatient nutrition and dietetic services and clear nutrition support protocols in COPD are lacking. It could be argued that identification of clinics serving particularly deprived COPD patient populations could warrant additional nutrition and dietetic support. A recent study highlighted the clinical, economic and operational burden presented by malnutrition in a cohort of Australian COPD patients [13]. Therefore targeted nutritional interventions that take into account social factors, such as deprivation, could improve the management of COPD patients.

An increased prevalence of malnutrition is often associated with an increase in age [14] yet no such relationship was found in the present study. In contrast, the study found a significant negative relationship between age and deprivation, which is likely to have influenced the results. It is unclear whether this is a unique observation specific to the populations included in the study. One of the hospitals (site B) borders the New Forest National Park which is generally considered affluent and the patients attending this hospital tended to be older. Deprivation is complex and the IMD was chosen, as it is multi-faceted including several domains that seek to assess factors likely to contribute to an individual being deprived. Whilst malnutrition risk was associated with overall deprivation it was also found to be significantly associated with the IMD domains relating to health and disability, barriers to housing, crime and living environment. Several of these domains, individually or combination, are likely to influence health behavior resulting in poorer nutritional intake and nutritional status. For example, the health and disability domain, including both physical and psychological disability, can adversely affect an individual's dietary intake and poor mental health and functional capacity can impair the ability to obtain, prepare and regularly eat a diet that is nutritionally adequate. Deprivation in education could potentially impact on compliance to pharmacotherapy and nutritional intervention strategies and to an individual's ability to identify a declining clinical condition and seek healthcare advice. Indeed, a US study found that deprivation was associated with a reduced adherence to statin medications [15] although, a UK study found no association [16]. Regardless, it would be prudent for future

nutritional intervention studies in this population to consider deprivation given its association with malnutrition risk.

Although challenges exist in the assessment of deprivation, the IMD is a useful tool that could be used to identify groups at risk of deprivation where malnutrition is likely to cluster. The information could lead to targeted nutritional interventions and appropriate resource allocation. Whilst this may improve clinical and economic outcomes it is not without logistical challenges as pockets of deprivation exist in all regions. An important consideration and a limitation of the current findings, is the fact that not all individuals residing in an area of deprivation will be deprived and not all deprived individuals will be at risk of malnutrition. In fact, the authors of the index of multiple deprivation suggested that it should be cautiously interpreted since it is not based on an individual's deprivation per se, but on the deprivation a person residing in the particular location (postcode) is likely to encounter. Another consideration is the generalizability of the current findings, In their publication 'Invisible lives' the British Lung Foundation outlined the areas within the UK with the highest prevalence of COPD [17]. The more deprived northern and central regions of England had substantially higher numbers of individuals with COPD and higher accompanying hospital healthcare use relating to the disease. Interestingly, the document listed the then primary care trusts (PCTs) throughout the UK where COPD presented the greatest burden in terms of hospitalization rates. Hampshire, where the current study was carried out, was ranked third from the bottom as an area facing the least burden from the disease. Yet both Hampshire hospitals had a large number of malnourished COPD patients (28% and 17%) attending outpatient appointments, with a significantly higher number at the larger city hospital (site A) despite the small geographical distance between the sites. Therefore, further research is needed to obtain insight into the burden of malnutrition in patients with COPD in other areas of the country, including more deprived localities where the prevalence may be considerably higher than the current findings. In addition, the use of deprivation index measures based on European statistics [18] may also allow for comparisons to be made between countries. This French index is based on perceptions of inequalities as well as individual information such

as income but no health domain. However, similar to those indexes from North America [19, 20], without assessment of individual deprivation domains it does make interpretation between nationalities challenging.

Within the area of clinical nutrition, deprivation has been rarely explored, most likely due to the complex nature of deprivation and poor nutritional status compounded against a backdrop of ill health. The secondary analysis by Elia and Stratton [21] of data from the National Diet and Nutrition Survey (NDNS) undertaken in England revealed a gradient in protein-energy malnutrition according to 'MUST' between the north and the south, with the greatest prevalence of malnutrition in the north. There was also a progressive deterioration in nutrient status (more deficiencies), including vitamin C and other anti-oxidants, between the north, central and southern regions respectively. These findings, together with greater prevalence of malnutrition according to 'MUST' in northern regions, suggests that COPD patients could be at considerable risk, especially since the burden of COPD is greater in northern regions. For example, in COPD with existing elevated systemic inflammation and oxidative stress, a low intake and status of vitamin C and other antioxidants, which are more common in those with a high 'MUST' risk, could predispose to worsening of respiratory function precipitated by recurrent infective exacerbations of the disease [22]. While malnutrition in COPD has long been considered a clinical problem [23], recent meta-analyses have shown it is amenable to treatment [24], particularly with multi-nutrient liquid oral supplements and amongst other functional improvements, results in a significant improvement in pulmonary muscle function [25]. However, no nutritional support studies in malnourished COPD patients to our knowledge have considered deprivation despite it potentially influencing the effectiveness of intervention strategies through several mechanisms. These could include compliance to treatment, health beliefs and dietary adequacy on enrolment, and from the literature it appears that this has not been adequately investigated. Prescott et al [26], found a strong social gradient in COPD, particularly in males, which was related to mortality [26], but unfortunately neither nutritional status or intake were assessed. However, a recent review found that males living alone more often consumed unhealthy diets including

fewer fruits and vegetables [27], and a trial in a COPD population, found those patients randomised to consume a diet rich in fruits and vegetables improved their lung function [28]. The clustering of deprivation, smoking status, malnutrition and poor dietary quality all warrant consideration in future nutrition intervention studies in this patient group. The current study found a significant and independent association between both severity of COPD and smoking status and malnutrition risk. Whilst COPD severity is irreversible, smoking status is a modifiable behavior and smoking cessation in malnourished patients could be a particularly impactful therapeutic intervention as it has been associated with weight gain [29].

Apart from assessing deprivation in small geographic areas, rather than in individuals, this study has other limitations. One of these is the lack of data on the quality and quantity of dietary intake, which influences risk of malnutrition. More detailed data on smoking history, including quantitative information on the number of cigarettes smoked, would have allowed more complex adjustments and interactions to be examined. However, although smoking was found to be related both to deprivation and malnutrition, it may not be appropriate to control for smoking when examining deprivation differences and the risk of malnutrition. This is because on clinical and physiological grounds, some of the effects of smoking are thought to involve part of the causal pathway [30] such as the association between weight gain and smoking cessation [29]. In the present study significant associations were observed before and after adjustment for smoking status.

In summary, this study suggests for the first time that deprivation is a significant predictor of malnutrition risk in outpatients with COPD. This study indicates that a combination of malnutrition and deprivation is common in this patient group and that deprivation should be considered as part of the nutritional management of COPD to allow more appropriate targeted nutritional support interventions to be delivered.

References

1. Marmot, M., et al., *Fair Society, Health Lives. The Marmot Review. Strategic Review of Health Inequalities in England post-2010.*, UCL Institute of Health Equity. 2010. p. 1-242.
2. Townsend, P., *Poverty in the United Kingdom.* 1979: Penguin.
3. Stratton, R.J. and M. Elia, *Deprivation linked to malnutrition risk and mortality in hospital.* The British journal of nutrition, 2006. **96**(5): p. 870-6.
4. Elia, M., *The 'MUST' Report: Nutritional Screening for Adults - a multidisciplinary responsibility.* Malnutrition Action Group (MAG). 2003: British Association of Parenteral and Enteral Nutrition (BAPEN): Redditch, UK.
5. Noble, M., et al., *The English Indices of Deprivation 2007,* Communities and Local Government: 2008: London.
6. Hawker, J.I., et al., *Social deprivation and hospital admission for respiratory infection: an ecological study.* Respiratory Medicine, 2003. **97**(11): p. 1219-24.
7. National Clinical Guideline Centre. *Chronic obstructive pulmonary disease in over 16s: diagnosis and management (CG101).* London: National Clinical Guideline Centre. 2010.
8. Stratton, R.J., C.J. Green, and M. Elia, *Disease-related malnutrition: an evidence based approach to treatment.* 2003, Oxford: CABI Publishing (CABI International).
9. Global Initiative for Chronic Obstructive Pulmonary Disease. *Pocket guide to COPD diagnosis, management, and prevention.* 2010.
10. Calderon-Larranaga, A., et al., *Association of population and primary healthcare factors with hospital admission rates for chronic obstructive pulmonary disease in England: national cross-sectional study.* Thorax, 2011. **66**(3): p. 191-6.
11. Struthers, A.D., et al., *Social deprivation increases cardiac hospitalisations in chronic heart failure independent of disease severity and diuretic non-adherence.* Heart, 2000. **83**(1): p. 12-6.
12. Hunter, L.C., et al., *Patient characteristics associated with risk of first hospital admission and readmission for acute exacerbation of chronic obstructive pulmonary disease (COPD) following primary care COPD diagnosis: a cohort study using linked electronic patient records.* BMJ Open, 2016. **6**(1): p. e009121.
13. Hoong, J., et al., *Economic and operational burden associated with malnutrition in chronic obstructive pulmonary disease.* Clinical Nutrition, In Press.
14. Russell, C. and M. Elia, *Nutrition screening survey in the UK and Republic of Ireland in 2011.* 2012.
15. Avorn, J., et al., *Persistence of use of lipid-lowering medications - a cross-national study.* JAMA : the journal of the American Medical Association, 1998. **279**(18): p. 1458-1462.
16. Wei, L., et al., *Adherence to statin treatment and readmission of patients after myocardial infarction: a six year follow up study.* Heart, 2002. **88**(3): p. 229-33.

17. British Lung Foundation. *Invisible Lives: Chronic Obstructive Pulmonary Disease (COPD) - finding the missing millions*. 2007: London.
18. Pornet, C., et al., *Construction of an adaptable European transnational ecological deprivation index: the French version*. J Epidemiol Community Health, 2012. **66**(11): p. 982-9.
19. Eibner, C. and R. Sturm, *US-based indices of area-level deprivation: results from HealthCare for Communities*. Soc Sci Med, 2006. **62**(2): p. 348-59.
20. Pampalon, R. and G. Raymond, *A deprivation index for health and welfare planning in Quebec*. Chronic Dis Can, 2000. **21**(3): p. 104-13.
21. Elia, M. and R.J. Stratton, *Geographical inequalities in nutrient status and risk of malnutrition among English people aged 65 y and older*. Nutrition, 2005. **21**(11-12): p. 1100-6.
22. Siedlinski, M., et al., *Lung function loss, smoking, vitamin C intake, and polymorphisms of the glutamate-cysteine ligase genes*. Am J Respir Crit Care Med, 2008. **178**(1): p. 13-9.
23. Schols, A.M., *The 2014 ESPEN Arvid Wretling Lecture: Metabolism & nutrition: Shifting paradigms in COPD management*. Clin Nutr, 2015. **34**(6): p. 1074-9.
24. Collins, P.F., R.J. Stratton, and M. Elia, *Nutritional support in chronic obstructive pulmonary disease: a systematic review and meta-analysis*. Am J Clin Nutr, 2012. **95**(6): p. 1385-95.
25. Collins, P.F., M. Elia, and R.J. Stratton, *Nutritional support and functional capacity in chronic obstructive pulmonary disease: a systematic review and meta-analysis*. Respiriology, 2013. **18**(4): p. 616-29.
26. Prescott, E., et al., *Social position and mortality from respiratory diseases in males and females*. Eur Respir J, 2003. **21**(5): p. 821-6.
27. Hanna, K.L. and P.F. Collins, *Relationship between living alone and food and nutrient intake*. Nutr Rev, 2015. **73**(9): p. 594-611.
28. Keranis, E., et al., *Impact of dietary shift to higher-antioxidant foods in COPD: a randomised trial*. Eur Respir J, 2010. **36**(4): p. 774-80.
29. Williamson, D.F., et al., *Smoking cessation and severity of weight gain in a national cohort*. N Engl J Med, 1991. **324**(11): p. 739-45.
30. Kirkwood BR, S.J., *Essential Medical Statistics*. 2005, Blackwell Science: Oxford. p. 462-465.

Table 1 Characteristics and malnutrition risk of COPD outpatients attending two hospitals; Southampton General Hospital (site A) and Lymington New Forest Hospital (site B).

	Site A (n = 190)	Site B (n = 234)	Total (n = 424)	p-value
Demographics				
Females (n)	93	109	202	
Males (n)	97	125	222	0.628
Age (years)+	71.9 ± 10.1 ^a	73.6 ± 9.7 ^c	72.9 ± 9.9 ^d	0.078
Height (m)+	1.65 ± 0.1 ^b	1.66 ± 0.9	1.66 ± 0.9 ^e	0.208
Weight (kg)+	69.8 ± 20.2	72.6 ± 18.1	71.4 ± 19.1	0.134
BMI (kg/m ²)+	25.4 ± 6.7	26.1 ± 6.0	25.8 ± 6.3	0.232
IMD score+	21.25 ± 12.43	11.56 ± 7.38	15.90 ± 11.06	<0.001
IMD rank+	15510 ± 8137	22877 ± 6828	197576 ± 8289	<0.001
'MUST' risk				
Cat³ (n (%))				
Low	136 (72%)	195 (83%)	331 (78%)	
Medium	24 (12%)	14 (6%)	38 (9%)	
High	30 (16%)	25 (11%)	55 (13%)	0.010
'MUST' risk				
Cat² (n (%))				
Low	136 (72%)	195 (83%)	331 (78%)	
Medium + High	54 (28%)	39 (17%)	93 (22%)	0.004

+ For continuous variables the results are presented as mean ± SD, and the analysis was based on ANOVA. The other categorical variables are analysed using the Chi squared test
^{a-e} information not always available on all subjects: ^a n=180, ^b n=186, ^c n=233, ^d n=413, ^e n=420,

MUSTCat² = Low versus Medium + High 'MUST' scores; MUSTCat³ = Low versus Medium versus High 'MUST' scores.

Table 2 The rank index of multiple deprivation (IMD rank), and rank within individual domains of IMD by malnutrition risk ('MUST' medium + high risk) in COPD (n = 424 outpatients)+

Deprivation domains (rank)	'MUST' risk		P
	(Low risk) (n = 331)	(Medium + High risk) (n = 93)	
Overall IMD	17.5 ± 8.2	20.2 ± 8.2	0.007
Income	16.6 ± 8.2	18.2 ± 8.1	0.092
Employment	17.8 ± 7.5	19.5 ± 7.5	0.051
Health & disability	18.7 ± 8.1	21.5 ± 8.0	0.003
Education skills & training	14.9 ± 9.2	16.7 ± 8.6	0.090
Barriers to housing	15.7 ± 7.4	17.8 ± 8.1	0.024
Crime	15.9 ± 8.9	18.7 ± 9.1	0.008
Living environment	18.1 ± 8.2	20.9 ± 8.0	0.003

Results are presented as mean ± SD. P values established using ANOVA.

+ Parallel analysis with IMD score yielded mirrored the results in the table with significant differences for overall IMD score (p = 0.018), health deprivation and disability (0.002), barriers to housing (p = 0.043), crime (p = 0.010), and living environment (p = 0.008)

Table 3 The relationship between malnutrition risk ('MUST' medium + high risk) and components of the rank index of multiple deprivation (IMD) ($\times 0.001$) adjusted for COPD disease-severity, smoking status and age (n = 384 outpatients)+

Deprivation domains (score)	Odds ratio (95% CI)	p
Overall rank IMD	0.959 (0.939 - 0.999)	0.046
Income	0.985 (0.954 - 1.017)	0.362
Employment	0.975 (0.943 - 1.009)	0.146
Health deprivation & disability	0.965 (0.935 - 0.996)	0.025
Education skills & training	0.985 (0.956 - 1.015)	0.320
Barriers to housing	0.963 (0.931 - 0.995)	0.025
Crime	0.969 (0.941 - 0.997)	0.015
Living environment	0.967 (0.937 - 0.997)	0.033

+ Parallel analysis with IMD scores also yielded significant odds ratios for individual domains: health deprivation and disability (0.018), barriers to housing crime (p = 0.043), crime (p = 0.032) and living environment (p = 0.033).

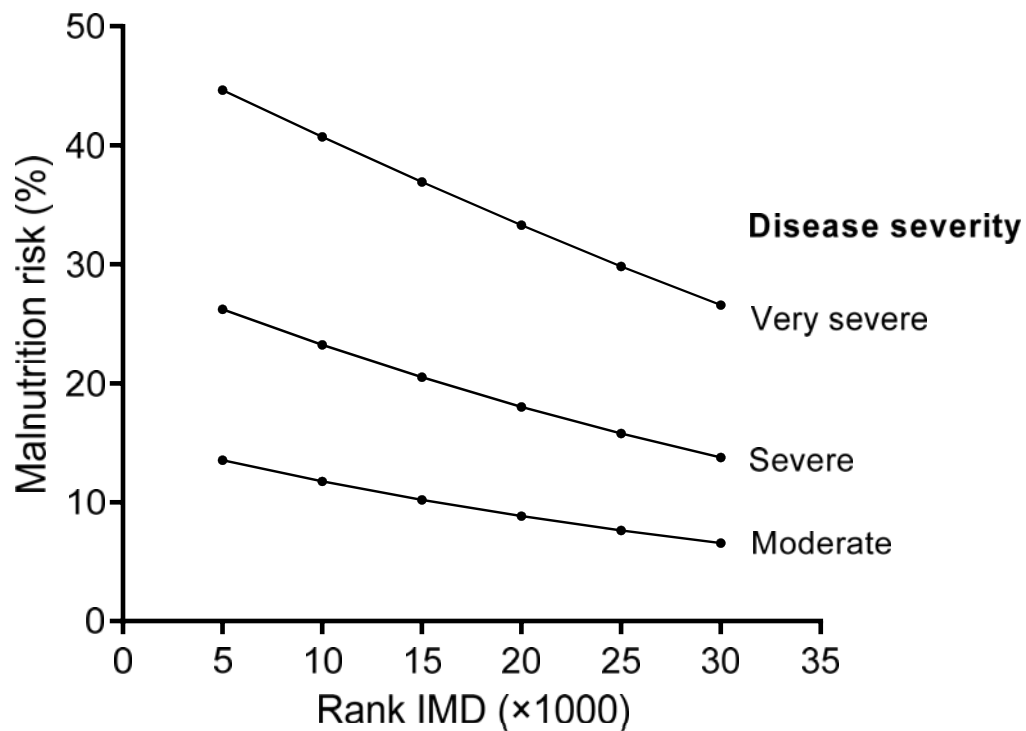


Figure 1 Malnutrition risk ('MUST' medium + high risk) in relation to rank deprivation (IMD) according to disease severity analysed using binary logistic regression and adjusting for age, smoking, disease-severity (GOLD criteria) and rank deprivation (IMD). The higher the rank IMD the lower the deprivation. Disease-severity ($p < 0.001$) was positively associated with the prevalence of malnutrition risk whilst the rank IMD ($p < 0.05$) was negatively associated with malnutrition seen in outpatients with COPD.