GLIM-based malnutrition, protein intake and diet quality in preprocedural Transcatheter Aortic Valve Implantation (TAVI) patients

Author(s)
van Erck, D.; Tieland, M.; Adriaens, N. W.; Weijs, P. J. M.; Scholte Op Reimer, W.J.M.; Henriques, J.P.; Schoufour, J.D.

DOI
10.1016/j.clnesp.2022.08.028

Publication date
2022

Document Version
Final published version

Published in
Clinical Nutrition ESPEN

Clinical Nutrition ESPEN 51 (2022) 481–485

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Short Communication

GLIM-based malnutrition, protein intake and diet quality in preprocedural Transcatheter Aortic Valve Implantation (TAVI) patients

D. van Erck [a, b, *], M. Tieland [b], N.W. Adriaens [a], P.J.M. Weijs [b, c], W.J.M. Scholte op Reimer [a, d], J.P. Henriques [a], J.D. Schoufour [b, e]

[a] Department of Cardiology, Amsterdam UMC, University of Amsterdam, Amsterdam, the Netherlands
[b] Center of Expertise Urban Vitality, Faculty of Sports and Nutrition, Amsterdam University of Applied Sciences, Amsterdam, the Netherlands
[c] Department of Nutrition and Dietetics, Amsterdam University Medical Centers, VU Amsterdam, the Netherlands
[d] HU University of Applied Sciences, Research Group Chronic Diseases, 3584 CS, Utrecht, the Netherlands
[e] Center of Expertise Urban Vitality, Faculty of Health, Amsterdam University of Applied Science, Amsterdam, the Netherlands

ARTICLE INFO

Article history:
Received 2 March 2022
Accepted 22 August 2022

Keywords:
Malnutrition
GLIM
Cardiac patients
Protein intake
Dietary quality
TAVI

SUMMARY

Background & aims: Diagnosed prevalence of malnutrition and dietary intake are currently unknown in patients with severe aortic stenosis planned to undergo Transcatheter Aortic Valve Implantation (TAVI). This study describes the preprocedural nutritional status, protein intake and diet quality.
Methods: Consecutive preprocedural TAVI patients were asked to participate in this explorative study. Nutritional status was diagnosed with the global leadership initiative on malnutrition (GLIM) criteria. Preprocedural protein intake and diet quality were assessed with a three-day dietary record. To increase the record's validity, a researcher visited the participants at their homes to confirm the record. Protein intake was reported as an average intake of three days and diet quality was assessed using the Dutch dietary guidelines (score range 0–14, 1 point for adherence to each guideline).
Results: Of the included patients (n = 50, median age 80 ± 5, 56% male) 32% (n = 16) were diagnosed with malnutrition. Patients diagnosed with malnutrition had a lower protein intake (1.02 ± 0.28 g/kg/day vs 0.87 ± 0.21 g/kg/day, p = 0.04). The difference in protein intake mainly took place during lunch (20 ± 13 g/kg vs 13 ± 7 g/kg, p = 0.03). Patients adhered to 6.4 ± 2.2 out of 14 dietary guidelines. Adherence to the guideline of whole grains and ratio of whole grains was lower in the group of patients with malnutrition than in patients with normal nutritional status (both 62% vs 19%, p = 0.01). In a multivariate analysis diabetes mellitus was found as an independent predictor of malnutrition.
Conclusion: Prevalence of malnutrition among TAVI patients is very high up to 32%. Patients with malnutrition had lower protein and whole grain intake than patients with normal nutritional status. Furthermore, we found diabetes mellitus as independent predictor of malnutrition. Nutrition interventions in this older patient group are highly warranted.

1. Introduction

Aortic stenosis is the most common cardiac valve disease and its prevalence highly increases with age. The common treatment for patients with severe aortic stenosis is an open heart surgery known as Surgical Aortic Valve Replacement (SAVR). Alternatively, for frail and elderly patients the less invasive Transcatheter Aortic Valve Implantation (TAVI) is preferred. Despite the low invasiveness of TAVI, many of these frail and elderly patients experience poor clinical outcomes. Six months after the procedure 30% of the patients have a decline in physical performance on the 6-min walk test and at one year approximately 10% of the TAVI patients are deceased [1,2]. One of the major risk factors for these negative outcomes is malnutrition, indeed, the risk of malnutrition is linked to a twofold increase in mortality and a threefold increase in decline of physical performance after TAVI [3–5].

Among community-based older adults, low nutrient intake, specifically low protein intake and low diet quality are the main underlying causes of malnutrition [6,7]. TAVI patients are at high risk for both inadequate protein intake and low diet quality, caused by a combination of lower appetite and higher need [6]. Indeed, several experts agree that the protein requirements for older adults

* Corresponding author. Department of Cardiology, Amsterdam UMC, University of Amsterdam, Amsterdam, the Netherlands..
E-mail address: d.vanerck@amsterdamumc.nl (D. van Erck).

https://doi.org/10.1016/j.clnesp.2022.08.028

with an acute or chronic illness, including TAVI patients, should be higher, between 1.2 and 1.5 g/kg/day [6]. Currently, the nutritional assessment in TAVI patients has only been conducted using the mini nutritional assessment (MNA), which is a screening tool for malnutrition and not a diagnosis of malnutrition [8]. Therefore, the prevalence of diagnosed malnutrition in TAVI patients is currently unknown. Moreover, dietary intake in these patients is unknown, while this information can be important for the scope of an effective nutrition intervention. The main aim of this study is to diagnose malnutrition and explore the protein intake and diet quality in preprocedural TAVI patients.

2. Materials and methods

2.1. Study design and participants

From May 2019 until January 2020 consecutive patients planned for a TAVI procedure were asked to participate in this cross-sectional observational study. All measurements took place approximately two to eight weeks before the cardiac procedure. Before enrollment, all included patients had to sign a written informed consent form. The study is in accordance with the declaration of Helsinki and has been approved by the local institutional review board (Medical Ethics Committee of the academic medical center in Amsterdam, the Netherlands).

2.2. Data collection

Nutritional status was diagnosed with the global leadership initiative on malnutrition (GLIM) criteria [9]. In accordance with the GLIM criteria malnutrition was diagnosed when one phenotypic and one etiologic criterium was present. Phenotypic criteria were: low BMI (<22), low muscle area (≤55.4 cm2/m2 in men or ≤ 38.9 cm2/m2 in women at lumbar vertebra 3 [10,11]) and involuntary weight loss (>3 kg in three months). Etiologic criteria were: reduced food intake (self-reported reduced appetite) and high inflammation: (C-reactive protein > 5 mg/L). Muscle area was determined on the preprocedural CT scan with the deep learning-based software of Quantib Body Composition (version 0.1.0, Quantib, Rotterdam, the Netherlands) [12].

Dietary intake was determined using a three-day dietary record. During three consecutive days participants were asked to document all consumed foods and drinks divided over six meals. To increase the validity of the record, a researcher (NA or DvE), visited the participants at their homes to confirm the record and add additional information when required. The Dutch national food composition database of 2016 was used to convert the dietary records into the nutrient intake.

Diet quality was assessed as adherence to the Dutch dietary guidelines 2015 [13]. The Dutch dietary guidelines describe recommendations for the intake of 14 food groups, based on high international evidence. Criterion validity of these guidelines was previously shown in a population-based prospective Dutch cohort (n = 9701) [13]. In line with this study, the following food groups and cut-off values were applied: vegetables (≥ 200 g/day), fruit (≥ 200 g/day), whole-grains (≥ 90 g/day), nuts (≥ 15 g/day), dairy (≥ 350 g/day), tea (≥ 450 ml/day), fish (≥ 100 g/week), legumes (≥ 135 g/week), sweet beverages (≤ 150 ml/day), alcohol (≤ 10 g/day), salt (≤ 6 g/day), red and processed meat (≤ 43 g/day), ratio whole-grains (≥ 50%) and ratio statured fat (≥ 50%). We used the sum of the number of guidelines adhered to (each a score of 1), with a theoretical range from 0 (no adherence) to 14 (full adherence).

In addition to above mentioned measurements, baseline characteristics as Euroscore II (risk score for cardiac surgical mortality) and New York Heart Association score (NYHA, classification based on limitations during physical activity) were determined. Furthermore, the access site of the heart valve implantation was reported, which was transfemoral (which does not require general anesthetics) or the more invasive transaortic access site (which requires general anesthetics).

2.3. Statistical analysis

Data are presented as the mean and standard deviation, median and interquartile range (IQR) or count and percentages depending on distribution. Total protein, energy intake and other macronutrient intakes in gram per day were determined using the average intake over three days. For calculation of protein intake per kg body weight, for patients with a BMI < 20 or > 30 kg/m^2, bodyweight was adjusted to match a BMI of respectively 20.0 or 27.5. Patient characteristics and dietary intake are compared between patients with normal nutritional status and patients with malnutrition. Differences were estimated using unpaired sample t-test, Wilcoxon signed-rank test, chi-square test or Fischer exact test depending on type of variable and distribution. To identify independent risk factors for malnutrition multivariate logistic regression are performed including age, sex and all patient characteristics with a P value < 0.10 in the univariable analysis. Analyses were performed using the program R statistical software, version 3.6.0.

3. Results

Of 77 patients assessed eligible, 22 declined to participate. The mean age of 50 included patients was 80 ± 5 years, and approximately half were male (56%) (Table 1).

In total, 32% (n = 16) of the patients were diagnosed with malnutrition based on the GLIM criteria (Table 2). Differences in patient characteristics between patients with normal nutritional status and malnutrition were seen for muscle mass in females (42.4 ± 6.8 vs 35.7 ± 6.7, p = 0.05) and diabetes mellitus in all patients (18% vs 63%, p < 0.01).

Table 1
Patient characteristics.

	Total	Normal nutritional status	Malnutrition	P value
Sample size, n (%)	50 (100)	34 (68)	16 (32)	
Sex = male, n (%)	28 (56)	19 (56)	9 (56)	1.00
Age (Years), mean ± SD	80 ± 5	79 ± 5	81 ± 6	0.47
Weight (kg), mean ± SD				
Male	87 ± 5	83 ± 12	94 ± 19	0.18
Female	76 ± 18	75 ± 17	78 ± 20	0.75
BMI (kg/m^2), mean ± SD				
Male	28.4 ± 5.3	27.3 ± 3.7	30.4 ± 4.8	0.12
Female	28.3 ± 4.3	28.5 ± 5.2	28.1 ± 5.8	0.87
Muscle Mass L3 (cm^2/m^2), mean ± SD				
Male	48.1 ± 7.4	48.1 ± 8.5	48.1 ± 5.1	0.99
Female	40.3 ± 7.4	42.4 ± 6.8	35.7 ± 6.7	0.05
Living Arrangement = Alone, n (%)	21 (42)	13 (38)	8 (50)	0.63
Diabetes mellitus = yes, n (%)	16 (32)	6 (18)	10 (63)	<0.01
Educational Level, n (%)				
Low	13 (26)	10 (30)	3 (19)	0.39
Middle	24 (48)	14 (40)	10 (62)	
High	13 (26)	10 (30)	3 (19)	
Smoking Status = no smoker, n (%)	46 (92)	31 (91)	15 (94)	1.00
NYHA-score = III/IV, n (%)	24 (48)	14 (41)	10 (63)	0.23
Euroscore-II, mean ± SD	2.6 ± 1.6	2.5 ± 1.7	2.7 ± 1.4	0.58
Access site = Transfemoral, n (%)	44 (88)	28 (82)	16 (100)	0.16

Table 2
Dietary intake and nutritional status.

Dietary intake	Total	Normal nutritional status	Malnutrition	P value
Energy intake (Kcal/day), mean ± SD	1728 ± 444	1782 ± 480	1614 ± 341	0.17
Energy intake (Kcal/kg/day), mean ± SD	23 ± 8	24 ± 9	21 ± 5	0.07
Carbohydrates intake (g/day), mean ± SD	185 ± 51	190 ± 37	174 ± 57	0.22
Monosaccharides (g/day), mean ± SD	86 ± 38	87 ± 42	82 ± 29	0.62
Polysaccharides (g/day), mean ± SD	99 ± 29	103 ± 30	92 ± 24	0.15
Fat intake (g/day), mean ± SD	66 ± 26	68 ± 29	62 ± 17	0.38
Saturated fat (g/day), mean ± SD	26 ± 11	26 ± 12	25 ± 9	0.58
Unsaturated fat (g/day), mean ± SD	34 ± 13	35 ± 15	31 ± 8	0.30
Protein intake (g/day), mean ± SD	73 ± 16	75 ± 17	67 ± 14	0.08
Animal protein (g/day), mean ± SD	48 ± 14	48 ± 15	46 ± 11	0.46
Plant protein (g/day), mean ± SD	25 ± 8	27 ± 9	22 ± 5	0.01
Protein intake (g/kg/day), mean ± SD	0.98 ± 0.27	1.02 ± 0.28	0.87 ± 0.21	0.04
<0.8 g/kg/day, n (%)	14 (28)	9 (26)	5 (31)	0.50
0.8–1.2 g/kg/day, n (%)	28 (56)	18 (53)	10 (63)	
>1.2 g/kg/day, n (%)	8 (16)	7 (21)	1 (7)	
Protein intake breakfast (g/kg), mean ± SD	13 ± 7	14 ± 7	11 ± 6	0.30
Protein intake lunch (g/kg), mean ± SD	18 ± 11	20 ± 13	13 ± 7	0.03
Protein intake diner (g/kg), mean ± SD	33 ± 12	33 ± 13	32 ± 10	0.73
Dutch dietary guideline, mean ± SD	6.4 ± 2.2	6.6 ± 2.1	5.9 ± 2.4	0.39
Nutritional status	**Total**	**Normal nutritional status**	**Malnutrition**	
Involuntary weight loss, n (%)	11 (25)	6 (18)	5 (31)	0.30
Low body mass index (BMI), n (%)	2 (4)	2 (6)	0 (0)	1.00
Reduced muscle mass, n (%)	35 (70)	21 (62)	14 (88)	0.10
Reduced food intake (lower appetite), n (%)	11 (22)	0 (0)	11 (69)	<0.01
Presence of inflammation, n (%)[a]	12 (24)	3 (9)	9 (56)	<0.01

SD, standard deviation; g, gram; kg, kilogram; GNRI, geriatric nutrition risk index; GLIM, Global Leadership Initiative on Malnutrition.
[a] C-reactive protein (CRP) > 5 mg/L.

Energy intake of the included TAVI-patients was 23 ± 8 kcal/kg/day (Table 2). The protein intake per kg ideal body weight was 0.98 ± 0.27 g/kg/day, which corresponded with 42 patients (84%) that did not meet the recommended intake of 1.2 g/kg/day. Protein intake differed between patients with normal nutritional status and patients with malnutrition (1.02 ± 0.28 vs 0.87 ± 0.21, p = 0.04). An average protein intake above 25 g per meal was met by 8% (n = 4) for breakfast, 18% (n = 9) for lunch and 72% (n = 36) for dinner. Difference in protein intake between the normal nutritional status group and malnourished group was mainly seen during lunch (20 ± 13 vs 13 ± 7, p = 0.03) (Fig. 1). No patients used oral nutritional supplements to increase protein or other macronutrient intake.

Regarding diet quality patients adhered to 6.4 ± 2.2 out of 14 guidelines. Differences in adherence for patients with a normal nutritional status compared to those with malnutrition were seen for the guidelines on whole grains (62% vs 19%, respectively, p = 0.01) and ratio of whole grains (62% vs 19%, p = 0.01) (Fig. 2).

After age, sex and diabetes mellitus were inserted as predictors of malnutrition in a multivariate logistic regression model, only diabetes mellitus emerged as an independent predictor of malnutrition in our study population. The OR for malnutrition was 1.11 [95%CI: 0.98 − 1.31] per year for age, 1.28 [95%CI: 0.32 − 5.38] for male sex and 12 [95%CI: 3 − 71] for diabetes mellitus.

4. Discussion

We observed that up to 32% of the TAVI patients were diagnosed with malnutrition based on GLIM criteria. GLIM is

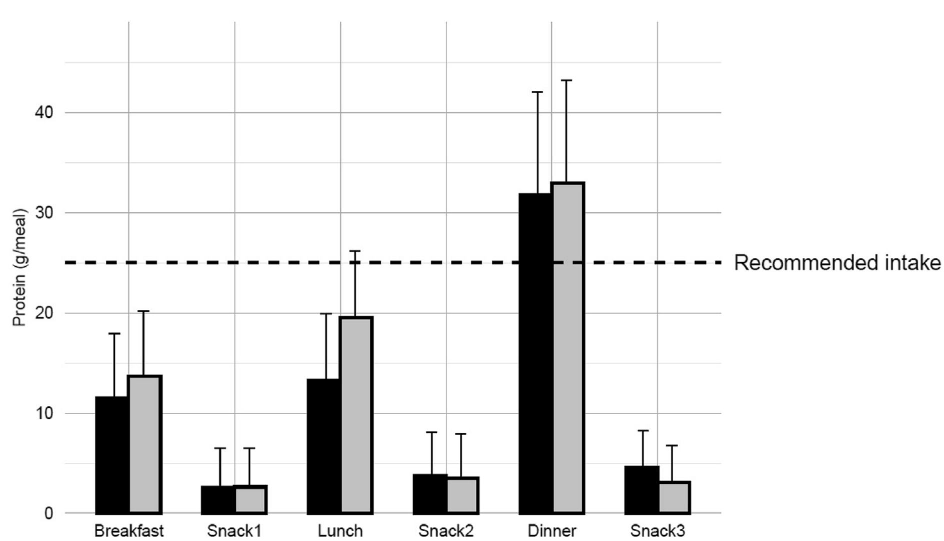

Fig. 1. Protein intake per meal, data are presented as mean ± SD. Black: malnutrition, grey: normal nutritional status.

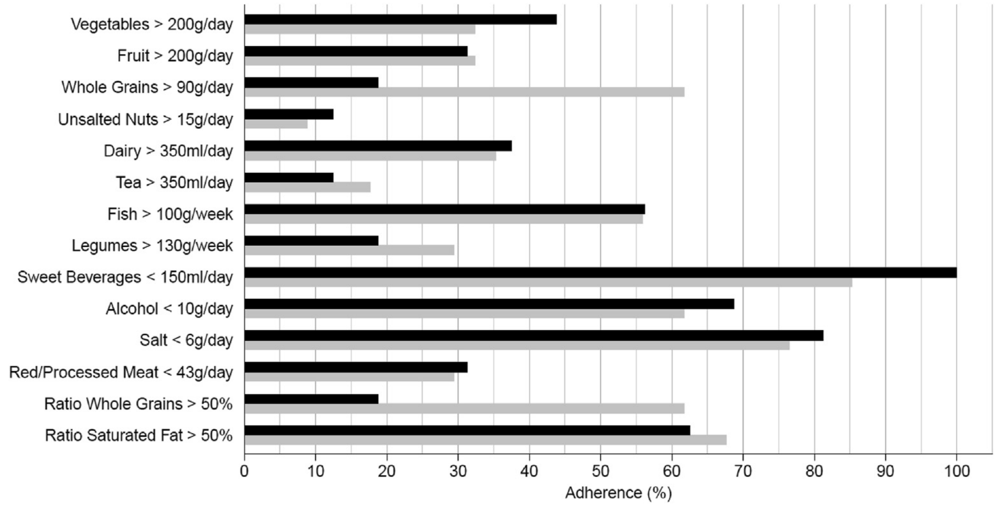

Fig. 2. Adherence to Dutch dietary guidelines, per guideline. Black: malnutrition, grey: normal nutritional status.

becoming the gold standard for the diagnosis of malnutrition and is based on strong consensus among a worldwide network of experts [9]. The GLIM criteria demonstrated excellent concurrent validity in specific populations, such as geriatric [14], cancer [15], and hemodialysis [16]. The prevalence of malnutrition in healthy older adults is generally somewhat lower (13 − 23%), depending on the used measurements and procedure [17]. As reduced food intake is one of the criteria for GLIM-based malnutrition, we also looked at differences in dietary intake between patients with malnutrition and normal nutritional status. We observed that protein intake and whole grain intake were lower in patients with malnutrition.

Expert consensus recommends a protein intake of 1.2 g/kg/day for older patients as patient planned for TAVI. Based on our observations a vast majority (84%) does not meet the suggested intake of 1.2 g/kg/day. Therefore most patients should be advised to increase their protein intake. Especially, patients that are malnourished, as they had lower protein intake than patients with a normal nutritional status, specifically during lunch. Only during dinner, which is the primary warm meal for most Dutch older adults, protein intake was sufficient in both groups. To subsequently increase diet quality, protein intake is preferably increased with the intake of dairy and nuts. In addition, consumption of whole grains is of importance, as patients with malnutrition had a lower adherence to the guideline of minimally 90 g of whole grains per day. Especially, since whole grains often contain more protein than refined grains. Furthermore, most patients should consume more fruits and vegetables since these guidelines had low adherence in both the malnourished and normal nutritional status group.

We observed diabetes mellitus as an independent predictor of malnutrition in patients planned for TAVI. Previous research in healthy older adults [18] and hemodialysis patients [19] already showed that diabetes mellitus is related to a poor nutritional status. Explanation may be an increased burden of disease in patients with diabetes mellitus, which leads to more hospitalizations and subsequent muscle loss, which is one of the phenotypic criteria for GLIM-based malnutrition [20,21]. Furthermore, diabetes mellitus is linked to a higher inflammation, which is one of the etiologic criteria of GLIM-based malnutrition [22]. For TAVI patients diabetes mellitus is a new risk predictor for malnutrition, suggesting that all diabetic TAVI patients require nutrition counseling before the procedure.

In general, TAVI patients are not routinely screened for malnutrition and referred to a dietician. This is in contrast to the strong evidence in other patient groups that nutritional support, especially in combination with an exercise program, can positively affect the nutritional status and clinical outcomes of patients [23]. Future research should focus at developing nutritional and exercise programs for specifically frail patients such as the TAVI patient.

This study has several limitations. A limitation is the monocenter design with a small sample size, which caused wide confidence intervals in multivariate analysis to identify independent risk factors for malnutrition. With current new insight in dietary intake future studies on this causal relation are warranted. In addition, dietary records could be affected by recall bias or changes in intake during the recording period. However, for the older population, the dietary record is a suitable tool [24]. In addition, home visits to validate the dietary record were an important strength to address possible recall bias [25].

In conclusion, we observed that a substantial part of the TAVI patients have malnutrition based on the GLIM criteria (up to 32%). Differences in food intake were seen in protein intake and whole grain intake, which were both lower in patients with malnutrition. In addition, we observed diabetes as an independent predictor of malnutrition. Routine screening for malnutrition and poor dietary intake are warranted and early referral to a dietician should be considered.

Funding

This research was supported by an internal grant of the Amsterdam UMC, grant number 171107/2017.03.xxx.

Data availability statement

Raw data is available at https://doi.org/10.21942/uva.16669363.

Author contributions

“Conceptualization, all authors; methodology, all authors; formal analysis, DE.; writing—original draft preparation, DE, JS; writing—review and editing, all authors; supervision, PW, WSOR, JH, JS. All authors have read and agreed to the published version of the manuscript.”

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgements

We want to thank all participants, the specialist nurses M. Holierook and E.V. Chekanova, who provided help in planning and inclusion of the patients. In addition, we want to thank J. de Vries and E. Dross, who provided support in processing of the dietary records.

References

[1] Abdul-Jawad Altisent O, Puri R, Regueiro A, Chamandi C, Rodriguez-Gabella T, del Trigo M, et al. Predictors and association with clinical outcomes of the changes in exercise capacity after transcatheter aortic valve replacement. Circulation 2017;136(7):632–43.
[2] Chakos A, Wilson-Smith A, Arora S, Nguyen TC, Dhoble A, Tarantini G, et al. Long term outcomes of transcatheter aortic valve implantation (TAVI): a systematic review of 5-year survival and beyond. Ann Cardiothorac Surg 2017;6(5):432–43.
[3] Schoenenberger AW, Stortecky S, Neumann S, Moser A, Jüni P, Carrel T, et al. Predictors of functional decline in elderly patients undergoing transcatheter aortic valve implantation (TAVI). Eur Heart J 2013;34(9):684–92.
[4] Eichler S, Salzwedel A, Harnath A, Butter C, Wegscheider K, Chiorean M, et al. Nutrition and mobility predict all-cause mortality in patients 12 months after transcatheter aortic valve implantation. Clin Res Cardiol 2018;107(4):304–11.
[5] Goudzwaard JA, Ronde-Tillmans MJ De, El N, Acar F, Mieghem NM Van, Lenzen MJ, et al. The erasmus frailty score is associated with delirium and 1-year mortality after transcatheter aortic valve implantation in older patients . The TAVI care & cure program. Int J Cardiol 2019;276:48–52.
[6] Deutz NEP, Bauer JM, Barazzoni R, Biolo G, Boirie Y, Bosy-Westphal A, et al. Protein intake and exercise for optimal muscle function with aging: recommendations from the ESPEN Expert Group. Clin Nutr 2014;33(6):929–36.
[7] Bloom I, Shand C, Cooper C, Robinson S, Baird J. Diet quality and sarcopenia in older adults : a systematic review. Nutrients 2018;10(3):1–28.
[8] Fukui S, Kawakami M, Otaka Y, Ishikawa A, Muraoka K, Yashima F, et al. Malnutrition among elderly patients with severe aortic stenosis. Aging Clin Exp Res 2020;32:373–9.
[9] Cederholm T, Jensen GL, Correia MITD, Gonzalez MC, Fukushima R, Higashiguchi T, et al. ESPEN Endorsed Recommendation GLIM criteria for the diagnosis of malnutrition - a consensus report from the global clinical nutrition community. Clin Nutr 2019;38:1–9.
[10] Mourtzakis M, Prado CMM, Lieffers JR, Reiman T, McCargar LJ, Baracos VE. A practical and precise approach to quantification of body composition in cancer patients using computed tomography images acquired during routine care. Appl Physiol Nutr Metabol 2008;33(5):997–1006.
[11] Bertschi D, Kiss CM, Schoenenberger AW, Stuck AE, Kressig RW. Sarcopenia in patients undergoing transcatheter aortic valve implantation (TAVI): a systematic review of the literature. J Nutr Health Aging 2021;25(1):64–70.
[12] Erck D Van, Moeskops P, Schoufour JD, Weijs PJM, Scholte WJM, Reimer O, et al. Evaluation of a fully automatic deep learning-based method for the measurement of psoas muscle area. Front Nutr 2022;9:781–860.
[13] Voortman T, Kiefte-De Jong JC, Arfan Ikram M, Stricker BH, Van Rooij FJA, Lahousse L, et al. Adherence to the 2015 Dutch dietary guidelines and risk of non-communicable diseases and mortality in the Rotterdam Study. Eur J Epidemiol 2017;32(11):993–1005.
[14] Hirose S, Matsue Y, Kamiya K, Kagiyama N, Hiki M, Dotare T, et al. Prevalence and prognostic implications of malnutrition as defined by GLIM criteria in elderly patients with heart failure. Clin Nutr 2021;40(6):4334–40.
[15] Liu C, Lu Z, Li Z, Xu J, Cui H, Zhu M. Influence of malnutrition according to the GLIM criteria on the clinical outcomes of hospitalized patients with cancer. Front Nutr 2021;8:1–8.
[16] Cohen-Cesla T, Azar A, Hamad RA, Shapiro G, Stav K, Efrati S, et al. Usual nutritional scores have acceptable sensitivity and specificity for diagnosing malnutrition compared to GLIM criteria in hemodialysis patients. Nutr Res 2021;92:129–38.
[17] Cederholm T, Barazzoni R. A year with the GLIM diagnosis of malnutrition - does it work for older persons? Curr Opin Clin Nutr Metab Care 2021;24(1):4–9.
[18] Qureshi AR, Alvestrand A, Danielsson A, Divino-Filho JC, Gutierrez A, Lindholm B, et al. Factors predicting malnutrition in hemodialysis patients: a cross- sectional study. Kidney Int 1998;53(3):773–82.
[19] Castaneda C, Bermudez OI, Tucker KL. Protein nutritional status and function are associated with type 2 diabetes in Hispanic elders. Am J Clin Nutr 2000;72(1):89–95.
[20] Sanz-París A, Martín-Palmero A, Gomez-Candela C, García-Almeida JM, Burgos-Pelaez R, Sanz-Arque A, et al. GLIM criteria at hospital admission predict 8-year all-cause mortality in elderly patients with type 2 diabetes mellitus: results from VIDA study. J Parenter Enteral Nutr 2020;44(8):1492–500.
[21] Jiang HJ, Friedman B, Stryer D, Andrews R. Multiple hospitalizations for patients with diabetes. Diabetes Care 2003;26(5):1421–6.
[22] Lontchi-Yimagou E, Sobngwi E, Matsha TE, Kengne AP. Diabetes mellitus and inflammation. Curr Diabetes Rep 2013;13(3):435–44.
[23] Liao C De, Tsauo JY, Wu YT, Cheng CP, Chen HC, Huang YC, et al. Effects of protein supplementation combined with resistance exercise on body composition and physical function in older adults: a systematic review and meta-analysis. Nutrients 2018;10(12):1916.
[24] Tieland M, Borgonjen-Van den Berg KJ, van Loon LJC, de Groot LCPGM. Dietary protein intake in community-dwelling, frail, and institutionalized elderly people: scope for improvement. Eur J Nutr 2012;51(2):173–9.
[25] Cantwell MM, Millen AE, Carroll R, Mittl BL, Hermansen S, Brinton LA, et al. Nutritional epidemiology A debriefing session with a nutritionist can improve dietary assessment using food diaries. J Nutr 2006;136(2):440–5.