



Predictive value of each geriatric assessment domain for older patients with cancer: A systematic review

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ABSTRACT

Background: A geriatric assessment (GA) is increasingly used to help guide treatment decisions in older patients with cancer. However, there is no consensus regarding which domains should be included in the GA. In addition, the field of geriatric oncology moves very fast and as a result many new studies have been published since the last review in 2015. Therefore, the objective of this systematic review is to evaluate which domains of the GA could predict patient-related treatment outcomes of older patients with cancer and thereby should be included in a GA.

Methods: A systematic literature search was performed for publications in English or Dutch between September 2006 and July 2017 addressing the association between individual domains of the GA and mortality, postoperative complications, or systemic treatment-related outcomes in older patients with cancer.

Results: Eight different domains were evaluated in 46 publications, namely functional status, nutritional status, cognition, mood, physical function, fatigue, social support, and falls. All eight domains were predictive for at least one of the investigated outcomes but the results were quite variable across studies. Physical function and nutritional status were the domains most often associated with mortality and systemic treatment-related outcomes, and the domain physical function was most often associated with postoperative complications.

Conclusion: Overall, this review demonstrates that the GA should minimally consist of physical function and nutritional status, when the aim is to predict patients-related outcomes of older patients with cancer, although the results are quite heterogeneous. For the other domains, the findings are too inconsistent to draw conclusions about their overall predictive ability.

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1. Introduction

More than half of patients newly diagnosed with cancer today are 65 years of age or older [1]. The number of older patients with cancer substantially increases as a result of increasing life expectancy, population aging, and steady increase of cancer incidence with advancing age. Unfortunately, because this group is underrepresented in clinical trials, there are less results on which to base treatment decisions [2]. This means that older patients with cancer are more likely to be treated according to recommended treatment guidelines for younger patients, resulting in over-treatment. On the other hand, some older patients are incorrectly denied treatment according to recommended guidelines for fear of higher complications and toxicity rates resulting in under-treatment. Both over-treatment and under-treatment have a strong negative impact on survival. Moreover, older patients often have other chronic health conditions in addition to cancer, which can further complicate life expectancy estimation, affect treatment tolerability, and modify treatment efficacy [3].

Furthermore, treatment decisions are complicated by the heterogeneity of the older population with regard to co-morbidity, physiological reserves, functional status, social network, and geriatric conditions, making treatment decisions complex. As a result, the biological or functional age can differ significantly from chronological age [4]. Because chronological age alone is a poor descriptor of the highly individualized process of aging, a systematic way of describing the heterogeneity is needed to help guide oncology treatment decisions. A geriatric assessment (GA) can fill this knowledge gap [5].

A GA is a multidisciplinary, multidimensional, and systematic assessment, and consists of validated scales to identify impairments in geriatric domains [6]. A GA-guided treatment improves survival, quality of life, functional status, and decreases the risk of hospitalization and nursing home placement in non-oncological patients [6]. Over the past decade, the GA has been suggested as a useful geriatric oncology tool for identifying any underlying undetected medical, functional, and psychosocial impairment that may complicate treatment, thereby helping to select the most appropriate treatment [7–9]. Also, several studies have shown associations between items of the GA and the risk of toxicity, morbidity, and mortality during cancer treatment in older patients [10].

The International Society of Geriatric Oncology (SIOG) has therefore recommended conducting some form of geriatric assessment in the older patient with cancer [4,11,12]. Despite their recommendation, there is no consensus regarding which domains should be included in the GA for patients with cancer. The SIOG suggests exploring several domains (functional status, fatigue, cognition, mental health status, social support, nutrition, and geriatric syndromes), but provides no clear recommendation [5]. In addition, several different measurement tools are available for investigating these domains, but no one tool has been proven superior to the others. There is also a variation in the cutoff scores for impairment of the tools, resulting in various compositions of the GA, making inter-study comparison difficult. For that reason, there is a need for uniformity in the GA.

To help decide which domains should be included in the GA, the predictive value of each individual domain should be known. To our knowledge, the most recently published overviews of the predictive abilities of individual domains of the GA were published in 2015, reporting literature searches performed in 2013 [13,14]. We have therefore concluded that a new systematic review is needed in order

to arrive at an overview of the most recent evidence. The aim of this systematic review is to systematically evaluate which domains of the GA could predict patient-related treatment outcomes defined as mortality, postoperative complications of elective surgery for solid tumors, systemic treatment-related outcomes as toxicity, completion of planned treatment, and dose modifications, and should be included in a GA for older patients with cancer.

2. Methods

2.1. Data Sources

In July 2017, a systematic search was conducted in four databases: MEDLINE, EMBASE, Cochrane, and Cinahl. The search strategy combined synonyms for 'older patients', 'cancer', 'geriatric assessment', 'mortality', 'treatment outcomes', and 'postoperative complications'. The search was executed in 'title and/or abstract', and was restricted to articles in English or Dutch with a publication date between September 2006 and July 2017 (to avoid outdated evidence). An experienced university librarian assisted in the literature search. The full search syntax is presented in Supplementary 1. The PRISMA statement was used for reporting this systematic review [15].

2.2. Study Selection

After duplicates were deleted, the studies were selected in two steps. In the first step, the results were screened based on potentially relevant title and abstract using predefined criteria. A study was eligible for inclusion if all of the following criteria were fulfilled: (1) the study reported on patients 65 years or older diagnosed with cancer (any type of solid tumors or hematological malignancies, except skin cancer), and (2) the study reported on longitudinal, observational, interventional, or retrospective studies that addressed the association between baseline geriatric assessment and the following patient-related outcomes: mortality, postoperative complications of elective surgery for solid tumors, and systemic treatment-related outcomes defined as toxicity of systemic treatment, completion of planned treatment, and dose modifications. Editorials, case studies, reviews, expert opinion papers, and studies that were published as abstracts only were excluded. Because comorbidity is a routine part of the oncological work-up and therefore not considered part of the geriatric assessment, studies assessing the association between comorbidity and patient-related outcomes were excluded. Furthermore, frailty was not considered as an individual domain of the GA since frailty has frequently been defined as the presence of one or more impairments in geriatric domains, e.g. weight loss, fatigue, or low physical activity.

The selection was performed independently by two authors (CB and DH). When one author was uncertain about whether the study met the inclusion criteria or the abstract was unavailable, the study was selected for full text screening. In the second step, the full text was independently reviewed by these authors using the same inclusion and exclusion criteria. Disagreements between authors were resolved by consensus. To obtain the one unavailable full text article, we contacted the authors by email. Finally, the reference list of each selected study was reviewed to identify any additional relevant article.

2.3. Quality Assessment

The two authors appraised the methodological quality of each of the selected studies independently. The Quality In Prognosis Studies (QUIPS) tool was used to assess the risk of bias for the following five domains (1) the study participation, (2) the study attrition, (3) the assessment of the domains of the GA, (4) the measurement of the outcomes, and (5) statistical analysis and reporting (Supplementary 2) [16,17]. These potential bias domains were rated as having high (0 points), moderate (0.5 points), or low risk of bias (1 point), based on the QUIPS study of Hayden et al. [17]. Next, we rated the study design. A prospective study was ranked as a low risk of bias (1 point) because the inclusion criteria, the prognostic factors, and outcomes are defined in advance, and the baseline and follow-up data are more often complete, which reduces the risk for data dragging [18]. As a result, a retrospective study was ranked as a high risk of bias (0 points).

Subsequently, the scores of the six items were added. The total score reflected the overall risk of bias of the study: the maximum total score of 6 was regarded as the study with the lowest risk of bias. All discrepancies were resolved by consensus. No study was excluded based on the quality assessment since our aim was to provide a comprehensive overview of all studies assessing the predictive ability of individual domains of the GA for older adults with cancer.

2.4. Data Abstraction, Synthesis and Analysis

The two authors extracted the data of each study included independently. A formal meta-analysis was not possible due to the heterogeneity in study designs, diversity in study populations, the use of different

geriatric assessment tools with different cutoff points, and the diversity in outcomes. Therefore, we summarized the results of the predictive ability of individual geriatric domains per outcome measure.

3. Results

The literature search in four databases yielded 881 citations. After removing duplications ($n = 50$) and screening on titles and abstracts, 122 full texts were reviewed. The full text of one citation remained unavailable, despite contacting the authors [19]. After this review, 46 publications remained eligible for inclusion (Fig. 1). Next, one publication was excluded because this publication reported the exact same cohort, data, and results as another publication included [20,21]. Reference checking yielded one additional relevant publication. In the end, 46 eligible publications remained for quality assessment and data analysis.

Overall, scores of the quality assessments ranged from 2.0 to 6.0, with a median value of 4.5 (Supplementary 3). Five publications had the lowest risk of bias with a maximum score of 6 [21–25].

4. Study Characteristics

An overview of the characteristics of the 46 eligible publications is shown in Table 1. More than half of the studies were published in 2014 or later (24 out of 46 studies, 52%). Of the 46 publications, 38 were prospective studies, six were retrospective studies, and two had an unclear study design. None of the publications reviewed reported a randomized controlled trial specifically designed to examine the effectiveness of geriatric assessment.

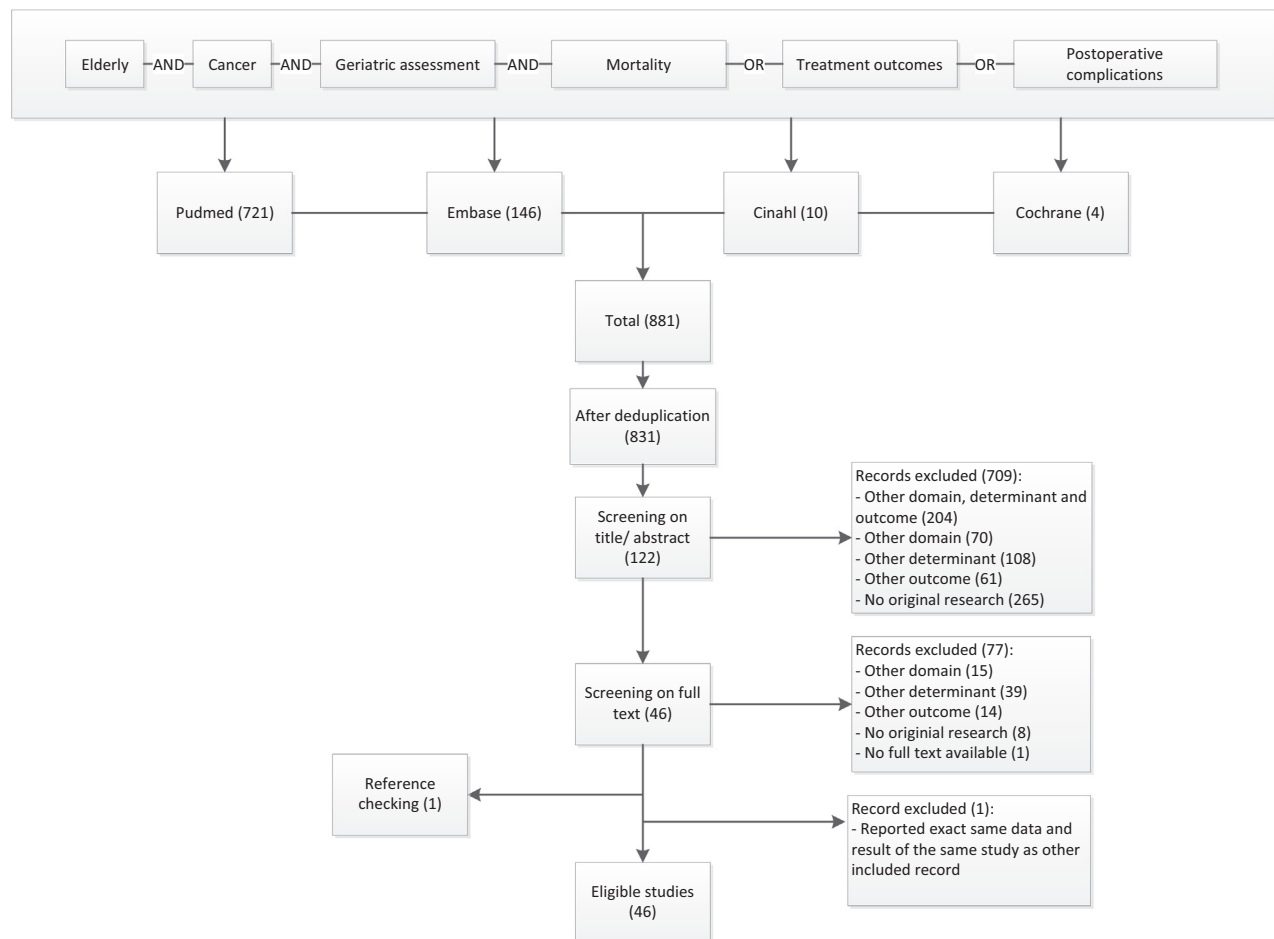


Fig. 1. Flowchart of study selection.

Table 1
Study characteristics.

Author (year)	Design	Aim of study	Sample size (% males)/country	Min. age	Age, median years (range)	Tumor type	Follow-up	Inclusion criteria	Geriatric domains of GA	Measurement tool of geriatric domain	Outcomes
Aaldriks [31]	Pros	To study the prognostic value of GA	55* (4) Netherlands	≥70 yr	76 ^a (70–88)	Breast cancer	0–57 months	Advanced cancer for whom chemotherapy was prescribed	Nutrition Cognition	MNA MMSE/IQCODE-N	Early withdrawal chemotherapy
Aaldriks [51]	Pros	To investigate the prognostic value of GA	44 (43) Netherlands	≥70 yr	78 ^a (70–86)	Non-Hodgkin Lymphoma	0–101 months	Fit for chemotherapy	Nutrition Cognition	MNA MMSE/IQCODE-N	Mortality Early withdrawal chemotherapy
Aaldriks [8]	Pros	To assess the prognostic value of GA for treatment with chemotherapy	202* (45) Netherlands	≥70 yr	77 ^a (71–92)	All cancer types	1–33 months	Chemotherapy was prescribed	Nutrition Cognition	MNA MMSE/IQCODE-N	Mortality < 4 cycles chemotherapy vs ≥4 cycles
Aaldriks [32]	Pros	To analyze which elements of geriatric screening program were predictive for chemotherapy and mortality	494 (49.9)* Netherlands	≥70 yr	75 (70–92)	All cancer types	1–101 months	Considered fit enough for chemotherapy	Nutrition Cognition	MNA MMSE/IQCODE-N	Mortality < 4 cycles chemotherapy vs ≥4 cycles
Aaldriks [33]	Pros	To assess the predictive value for tolerance of treatment	143 (59)* Netherlands	≥70 yr	75 ^a (70–92)	Colorectal	0.5–62 months	Eligible for chemotherapy treatment	Nutrition Cognition	MNA MMSE/IQCODE-N	Mortality < 4 cycles chemotherapy vs ≥4 cycles
Aparicio [66]	Pros	To identify predictive factors of treatment feasibility and toxicity	123 (54) France	≥75 yr	80.4 ^a (NR)	Colorectal	4 months	Fit for chemotherapy	Functional status: IADL Cognition Mood	Lawton-scale MMSE GDS	Mortality Grade 3 to 4 toxicity Dose reduction >33% Hospitalization Morbidity
Audisio [43]	Pros	To investigate the value of a GA in assessing the suitability for surgical intervention	460 (34) Europe and Japan	≥70 yr	76.9 ^a (70–95)	Solid tumors	1 months	Elective cancer surgery No emergency surgical management	Functional status: ADL IADL Cognition Mood Fatigue	Katz-scale Lawton-scale MMSE GDS BFI	Post-operative hospital stay
Badgwell [44]	Pros	To identify factors which may be associated with increased risk in older patients undergoing abdominal surgery	111 (55) United States of America	≥65 yr	72 (62–89)	Abdominal cancer	3 months	Abdominal cancer surgery	Functional status: IADL Nutrition Cognition Mood Fatigue Falls	Lawton-scale Amount of weight/6 months Mini-Cog Test GDS BFI Number of falls/6 months	Post-operative complications according to Clavien-Dindo scale Discharge to nursing facility
Baier [47]	Pros	Use of GA to predict risks and benefits of interventions	200 (69) Germany	≥70 yr	75 (70–88)	Abdominal cancer	6 months	Planned for elective surgery in curative intention, expected survival >6 months	Functional status: IADL Nutrition Cognition Physical function	Lawton-scale MNA MMSE GUG	Hospital readmission Dependence: ADL < 95

Baitar [67]	Pros	To evaluate the association between the Geriatric 8 and Groninger Frailty Index and severe treatment toxicity	85 (48) Belgium	≥65 yr	66 (66–88)	All cancer types	1 months	(Radio)chemotherapy <3 weeks after screening	Functional status ^b : ADL IADL Nutrition ^b Cognition Mood ^b Social support ^b	Katz-scale Lawton-scale MNA MMSE GDS MOS-SSS	SAE after first cycle of (radio) chemotherapy
Biesma [68]	Pros	To evaluate whether a GA can be used as a tool to predict which patients benefit from chemotherapy	181 (77) Netherlands	≥70 yr	74 (70–87)	Non-Small Cell Lung Carcinoma	NR	Inoperable, WHO-performance score ≤ 2	Functional status: ADL IADL Cognition Mood Physical function	Katz-scale Lawton-scale MMSE GDS TUG	Survival
Bila [69]	NR	To analyze the prognostic and treatment effect of IADL on the outcome of older patients	110 (50) Serbia	≥65 yr	NR	Multiple myeloma	NR	Treatment with chemotherapy	Functional status: IADL	Lawton-scale	AE Overall survival
Brunello [42]	Retro	To develop a cancer-specific multidimensional Prognostic Index for mortality prediction	658 (34) Italy	≥70 yr	77.16 ^a (70–96)	All cancer types	0–8. years	NR	Functional status: ADL IADL Cognition Mood Social support	Katz-scale Lawton-scale MMSE GDS Presence of caregiver	One-year mortality
Choi [45]	Retro	To evaluate the role of a scoring model in predicting adverse surgical outcomes	281 (0) Korea	≥65 yr	76.3 ^a (NR)	All cancer types	100 days	Low ASA risk, female, Korean patients undergoing curative cancer surgery	Functional status: ADL IADL Nutrition Cognition Mood	Barthel-index Lawton-scale MNA MMSE GDS	Post-operative complication Length of hospital stay
Clough-Gorr [41]	NR	To evaluate GA domains in relation to important outcomes	660 (0) United States of America	≥65 yr	NR	Breast cancer	7 years	Stage I, II or IIIA	Mood Social support	MHI5 MOS-SSS	Poor treatment tolerance according to opinion patient Mortality Survival
Denewet [70]	Pros	To assess to which extent GA could be seen as determinant of survival	205 (53) Belgium	≥70 yr	79 (70–93)	All cancer types	12 months	New diagnosis or disease progression	Functional status: ADL IADL Nutrition ^b Cognition ^b Mood ^b	Katz-scale Lawton-scale MNA-SF MMSE GDS	
Dubruille [71]	Pros	To investigate the predictive value of the different GA items	90 (51) Belgium	≥65 yr	74 (65–89)	Hematological cancer	1 year	Hospitalized for chemotherapy	Functional status: ADL IADL Nutrition Cognition Mood Fatigue Falls	Katz-scale Lawton-scale MNA MMSE GDS Mob-t Number of falls/last year	1-year overall survival
Extermann [49]	Pros	To create and validate in independent patients a predictive score with potential for clinical application	518(49.8) United States of America	≥70 yr	75.5 (70–92)	All cancer types	6 months	Histologically proven cancer and were initiating a new first line to fourth line	Functional status: IADL Nutrition	Lawton-scale MNA MMSE GDS	Grade 4 hematologic toxicity and/or grade 3–4

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Table 1 (continued)

Author (year)	Design	Aim of study	Sample size (% males)/country	Min. age	Age, median years (range)	Tumor type	Follow-up	Inclusion criteria	Geriatric domains of GA	Measurement tool of geriatric domain	Outcomes
Ferrat [26]	Pros	To identify GA findings associated with mortality	993 (51) France	≥70 yr	80.2 ^a (NR)	All cancer types	1 year	source of chemotherapy NR	Cognition Mood Functional status: ADL Nutrition Cognition Mood Physical function	Katz-scale MNA MMSE GDS GUG	non-hematologic toxicity Overall 1-year mortality
Ghosn [72]	Pros	To evaluate the predictive value of and abridged GA for mortality in older patients with cancer	100 (53) Lebanon	≥70 yr	76	All cancer types	Median 1418 days	A performance score ≥ 60 and a MMSE ≥23	Functional status: ADL IADL Nutrition Cognition Mood Physical function	Katz-scale Lawton-scale MNA MMSE GDS TUG	Overall survival
Giantin [22]	Pros	To test the Multidimensional Prognostic Index	160 (45) Italy	≥70 yr	79.4 ^a (69–93)	Solid tumors	12 months	Inoperable or metastatic solid cancer	Functional status: ADL IADL Nutrition Cognition Mood	Katz-scale Lawton-scale MNA SPMSQ/MMSE GDS	Mortality
Gírones [34]	Pros	To investigate the association of GA variables with function and survival	83 (97.6) Spain	≥70 yr	77 ^a (NR)	Lung cancer	2 years	Lung cancer at any stage	Functional status: ADL IADL Nutrition Cognition Mood	Katz-scale ? Amount of weight loss/3 months MMSE GDS	Mortality
Goede [30]	Pros	To investigate the association between GA and treatment outcome	75 (61) Germany	No cutoff point: 8% below 65 years	75 (48–87)	Chronic Lymphocytic Leukemia	5 years	Treatment with chemotherapy in the Chronic Lymphocytic Leukemia-9 trial	Functional status: IADL Cognition Physical function	Lawton-scale DEMTECT TUG	Dose reduction Treatment delay Treatment discontinuation Overall survival
Hamaker [73]	Pros	To evaluate the association between baseline GA and toxicity	78 (0) Netherlands	≥65 yr	75.9 (65.8–86.8)	Breast cancer	Median 32 months	Metastatic breast cancer patients treated with first line chemotherapy	Functional status: IADL Nutrition Cognition Mood	Lawton-scale BMI MMSE GDS	Grade 3–4 toxicity Mortality
Hamaker [28]	Pros	To assess the value of Geriatric 8 in predicting 1-year mortality	108 (53) Austria	≥67 yr	78.2 (67.1–98.9)	Hematological malignancy	12 months	Newly diagnosed with a hematological malignancy	Functional status: ADL IADL Nutrition	Barthel-index Lawton-scale BMI MMSE GDS	1-year mortality

Hamaker [39]	Pros	To assess which geriatric conditions are associated with mortality	292 (51.2) Netherlands	≥65 yr	74.9 (65–96.2)	All cancer types	12 months	Patients admitted to general medicine or oncology	Cognition Mood Physical function Functional status: ADL IADL Nutrition Cognition Mood Social support	TUG Katz-scale Modified Katz-scale SNAQ IQ-CODE-SF GDS EDIZ	12-month mortality
Hoppe [48]	Pros	To determine factors associated with functional early functional decline during first-line chemotherapy in older patients	364 (59.2) France	≥70 yr	77.35 (70–93)	Colon, pancreatic, stomach, ovarian, bladder, prostate, lung, non-Hodgkin lymphoma, or cancer of unknown primary origin	4 weeks	Patients scheduled to receive first-line chemotherapy	Functional status ADL IADL Nutrition Cognition Mood Physical function	Katz-scale Lawton-scale MNA MMSE GDS TUG	Functional decline after first cycle of chemotherapy: any decrease in ADL score
Huisman [21]	Pros	To investigate the predictive ability of screening tools	328 (38.1)** Europe	≥70 yr	76 (70–96)	Solid tumors	1 month	Elective surgery for a solid tumor under general anesthesia	Functional status: ADL IADL Nutrition Cognition Mood Physical function	Katz-scale Lawton-scale NRS MMSE GDS TUG BFI	Major complication <30 days according to Clavien-Dindo scale
Huisman [23]	Pros	To determine the predictive value of the TUG	263(33.5) Europe	≥70 yr	76 (70–96)	Solid tumors	1 month	Elective surgery for a solid tumor	Fatigue Physical function	TUG	Major complication (gr 3–5) < 30 days according to Clavien-Dindo scale
Hurria [7]	Pros	To develop a predictive model for grade 3 to 5 toxicity	500(44) United States of America	≥65 yr	73 ^a (65–91)	Solid tumors	Until the end of chemotherapy	Diagnosis of cancer Stage I-IV and scheduled to receive a new chemotherapy	Functional status ^b : ADL IADL Nutrition ^b Cognition ^b Mood ^b Physical function Falls	Subscale of MOS Physical Health Subscale of OARS BMI BOMC HADS TUG Number of falls/6 months MOS-SSS	Major complication (gr 3–5) < 30 days according to Clavien-Dindo scale Grade 3 to 5 toxicity of chemotherapy
Jonna [74]	Retro	To identify factors associated with shorter survival after following hospitalization	803(51.8) United States of America	≥65 yr	72.5 (?)	All cancer types	6 years	All patients admitted to the oncology acute care for elders unit who underwent GA	Social support ^b Functional status: ADL IADL Cognition	Katz-scale Lawton-scale Clock	Overall survival

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Table 1 (continued)

Author (year)	Design	Aim of study	Sample size (% males)/country	Min. age	Age, median years (range)	Tumor type	Follow-up	Inclusion criteria	Geriatric domains of GA	Measurement tool of geriatric domain	Outcomes
Kanesvaran [35]	Retro	To determine the impact of each GA domain on overall survival	249(61.4) Singapore	≥70 yr	77 (70–94)	All cancer types	3 years	Diagnosis at any stage	Functional status: ADL IADL Nutrition Cognition Mood	Katz-scale Lawton-scale DETERMINE-NI Clock/MMSE GDS	Overall survival
Kenig [24]	Pros	To compare prevalence of frailty depending on the number of incorporated domains of GA and to evaluate its accuracy in predicting postoperative outcomes	75(56) Poland	≥65 yr	73 (65–93)	Solid abdominal tumors	1 month	In need of elective surgery under general anesthesia	Functional status: ADL ^b IADL Nutrition Cognition Mood	Katz-scale Lawton-scale MNA BOMC/Clock/MMSE GDS TUG BFI MOS-SSS	Any event within 30 days of surgery that required treatment Major complication
Kristjansson [36]	Retro	To identify independent predictors of post-operative complications and early mortality from a GA	182(43) Norway	≥70 yr	80	Colorectal cancer	14–34 months	Planned for surgery of a confirmed or suspected colorectal cancer	Functional status: ADL IADL Nutrition Cognition Mood	Barthel-index NEADL MNA MMSE GDS	Any and severe complications <30 days of surgery Mortality
Marinello [75]	Pros	To analyze the role of several factors, including GA, in predicting the occurrence of adverse events during chemotherapy	110(64) Italy	≥70 yr	75.1 (70–87)	Any stage of breast, lung and colorectal cancer	The whole treatment period (about 6 months)	Considered sufficiently fit to tolerate chemotherapy	Functional status: ADL IADL Cognition	Katz-scale Lawton-scale SPMSQ	Death Toxicity Treatment interruption Overall survival
Merli [76]	Pros	To evaluate which among the GA components could help better identify patients	94(34) Italy	≥65 yr	78 (65–93)	Diffuse large B-cell lymphoma (DLBCL)	Median 36 months	DLBCL and ECOG 0–3 This study describes the results of the frail patients according to GA	Functional status: ADL	NR	
Mokutani [46]	Pros	To determine whether GA could predict complications of colorectal cancer surgery	156(57) Japan	≥75 yr	80.2 ^a (75–94)	Colorectal cancer	Complications retrospectively analyzed	With planned radical surgery of confirmed or suspected colorectal cancer	Functional status: ADL Cognition Mood	Barthel-index MMSE GDS	Postoperative complications <30 days of surgery
Naito [50]	Retro	To examine whether items in the GA were associated with survival time	93(46) Japan	≥65 yr	77 (NR)	Non-Hodgkin Lymphoma	5 years	Who were admitted for the first time for the treatment of Non-Hodgkin Lymphoma	Functional status: ADL IADL Nutrition Cognition Mood	Barthel-index Lawton-scale BMI Hasegawa's scale GDS	Adverse events Overall survival
Ommundsen	Pros	To explore whether GA also predict	178(43)	≥70 yr	80	Colorectal cancer	5 years	Scheduled for elective	Functional	Barthel-index	1-year survival

[37]		1-year and 5-year survival	Norway	(70–94)				surgery for confirmed or suspected colorectal cancer	status: ADL IADL Nutrition Cognition Mood	NEADL MNA MMSE GDS	5-year survival
Park [38]	Pros	To evaluate the relation of the GA to tolerability and survival of chemotherapy	70(54.3) Korea	≥65 yr	73.5 (65–92)	Aggressive Non-Hodgkin Lymphoma (NHL)	11.8–31.3 months	NHL and treated with chemotherapy for curative intent	Nutrition Cognition Mood	MNA-SF MMSE GDS	Maintenance the planned therapy for 12 weeks or more
Puts [40]	Pros	To explore the association between frailty and treatment toxicity	112(30.4) Canada	≥65 yr	74.1 (65–92)	All cancer types	6 months	New diagnosis of solid tumor with or without metastasis, or hematological malignancy	Functional status: ADL IADL Nutrition Cognition Mood Physical function	Katz-scale OARS Weight loss MMSE HADS Self-report questions, 4 m gait speeds, hand grip strength with dynamometer EORTC QOL C30	Overall survival Severe toxicity grade 3–5 at 3 and 6 months Death at 6 months
Spina [77]	Pros	To evaluate the feasibility and efficacy of chemotherapy modulated according to a modified GA	100(41) Italy	≥70 yr	75 (70–89)	Diffuse large B-cell lymphoma	Minimal 5 years	No previous chemotherapy	Fatigue Functional status: ADL IADL	Katz-scale Lawton-scale	Overall survival
Soubeyran [29]	Pros	To use GA to search for factors associated with higher risk of early death	364(59.5) France	≥70 yr	77.45 (70–99.4)	All cancer types (breast excluding)	6 months	Scheduled to receive first-line chemotherapy	Functional status: ADL IADL Nutrition Cognition Mood Physical function	Katz-scale Lawton-scale MNA MMSE GDS TUG	Death <6 months of chemotherapy
Suh [25]	Pros	To evaluate the associations of GA with surgical complications	60(0) Korea	≥70 yr	73 (70–85)	Gynaecologic cancer	30 days	Who were scheduled to undergo selective surgery	Functional status: ADL IADL Nutrition Cognition Mood Fatigue	Barthel-index Lawton-scale MNA MMSE GDS BFI	Postoperative complications <30 days
Ugolini [27]	Pros	To investigate the variables capable of predicting the long-term risk of mortality	46(52) Italy	≥70 yr	80.5	Colorectal cancer	Median follow-up 4.6 years (range 2.9–5.7)	Undergoing elective surgery for colorectal cancer	Functional status: ADL IADL Nutrition Cognition Mood Physical function Fatigue	Katz-scale Lawton-scale MNA MMSE GDS TUG BFI	Long-term mortality Living situation: but number of surviving patients were to small

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Table 1 (continued)

Author (year)	Design	Aim of study	Sample size (% males)/country	Min. age	Age, median years (range)	Tumor type	Follow-up	Inclusion criteria	Geriatric domains of GA	Measurement tool of geriatric domain	Outcomes
Wildes [78]	Pros	To determine whether geriatric assessments are associated with completion of a chemotherapy course	65(41.5) United States of America	≥65 yr	73 (65–89)	Colorectal, lung or breast cancer or lymphoma	0.01–47 months	Who were likely to begin a course of chemotherapy	Functional status: ADL IADL Nutrition Cognition Mood Falls	Katz-scale Lawton-scale BMI Unknown Number of falls/past month	Completion of chemotherapy Grade III/IV toxicity of chemotherapy Survival

Abbreviations: ADL, Activities of Daily Living; AE, Adverse Event; ASA, American Society of Anesthesiologists; BFI, Brief Fatigue Inventory; BMI, Body Mass Index; BOMC, Blessed Orientation-Memory-Concentration Test; GA, Comprehensive Geriatric Assessment; DEMTECT, Dementia Detection Test; DETERMINE-NI, DETERMINE nutritional index; ECOG, Eastern Cooperative Oncology Group; EDIZ, Experienced Burden of Informal Care; EORTC QOL C30, Organization for Research and Treatment of Cancer Quality of life questionnaire fatigue subscale; GDS, Geriatric Depression Scale; GUG, Get-up and Go test; HADS, Hospital Anxiety and Depression Scale; IADL, Instrumental Activities of Daily Living; ILOCODE-N, Informant Questionnaire on Cognitive Decline in the Older patients the short Dutch translation; MIH5, Five-item Mental Health Index; Mini-Cog, Mini Mental State Examination; MNA-SF, Mini-Nutritional Assessment; MNA-SF, Mini-Nutritional Assessment Short-Form (MNA-SF); Mob-t, Mobility-tiredness scale; MOS, Medical Outcomes Study Social Support Scale; NEADL, Nottingham Extended Activities of Daily Living Scale; NR, not reported; NRS, Nutritional Risk Screening; OARS, Older Americans Resources and Services European; Pros, Prospective; Retro, Retrospective; SAE, Severe Adverse Event; SNAQ, Short Nutritional Assessment Questionnaire; SPMSQ, Short Mental Status Questionnaire; TUG, Time Up and Go test; WHO, World Health Organization.

* Same cohort

** Same cohort

^a Mean age instead of median age

^b Results of this domains not described

twelve studies focused on patients with one specific solid tumor type, nine studies included patients with a hematological malignancy, and 25 studies focused on patients with various types of cancer. In total, the 46 publications comprised data of 9985 unique patients of 44 different cohorts. An average of 49% of the patients were males. The median number of patients enrolled was 150 (range 44–993). The age of the patients ranged from 65 to 99 years. The following geriatric domains were assessed as being part of a GA: functional status, nutritional status, cognition, mood, physical function, fatigue, social support, and falls. The median number of geriatric domains of the GA reported by study was four (range one–seven).

5. Mortality

Thirty-two studies analyzed which domains of the geriatric assessment were predictive for mortality (Table 2). Physical function, assessed with the Time-up and Go-test (TUG), Get-up and Go test (GUG), four-meter gait speed, or hand grip strength, was found to be the domain most often associated with mortality in five out of eight studies (63%) [26–30].

Nutritional status was associated with mortality in thirteen out of 23 studies (57%) [8,26,29,31–40]. For Activities of Daily Living (ADL), Instrumental Activities of Daily Living (IADL), cognition, mood, fatigue, and falls, <50% of the studies found an association with mortality. In the three studies that assessed the association between social support, no association was found [39,41,42].

6. Postoperative Complications

As shown in Table 3, nine studies addressed the association between individual geriatric domains and postoperative complications within 30 days [21,23–25,36,43–46], while one study assessed the association with postoperative dependency [47].

Physical function was also the most associated geriatric domain for postoperative complications in three out of four studies (75%) [21,23,24]. In the only study that assessed this domain, social support was a statistically significant predictive factor for postoperative complications [24].

For ADL, IADL, nutrition, cognition, mood, fatigue, and falls, <50% of the studies found an association.

7. Systemic Treatment-Related Outcomes

Nineteen studies, listed in Table 4, examined the ability of individual geriatric domains to predict systemic treatment-related outcomes. Because all studies examined the outcomes of chemotherapy treatment and no study included patients treated with anti-hormone, immune, or targeted therapy, we will therefore hereinafter call systemic treatment-related outcomes chemotherapy-related outcomes. Chemotherapy-related outcomes consisted of toxicity of chemotherapy, including dose modifications due to toxicity, early withdrawal of chemotherapy, and functional decline after the first cycle of chemotherapy.

All four studies found that physical function was predictive for chemotherapy-related outcomes (100%) [7,30,40,48].

Furthermore, eight out of fourteen studies found that malnutrition was predictive for chemotherapy-related outcomes (57%) [8,32,33,38,48–51]. Malnutrition was especially predictive for the risk of early withdrawal of chemotherapy in 86% of the studies (five out of six) [8,32,33,38,51]. For falls, one out of two studies (50%) found an association with toxicity of chemotherapy [7].

Finally, <50% of the studies found an association between toxicity of chemotherapy and social support, ADL, IADL, cognition, and mood. For fatigue and mobility, no association was found.

8. Discussion

Since the SIOG's recommendation to conduct a GA, many studies were published about the predictive ability of individual GA domains for relevant oncological outcomes. However, the composition of the GA differs between studies, which makes inter-study comparison difficult. The aim of the current systematic review was to systematically evaluate which domains of the GA could predict patient-related treatment outcomes and should be included in a GA for patients with cancer. Patient-related outcomes were defined as mortality, postoperative complications of elective surgery for solid tumors, and chemotherapy-related outcomes as toxicity, completion of planned treatment, and dose modifications.

In this systematic review, eight geriatric domains were evaluated in 46 publications, namely functional status, nutritional status, cognition, mood, physical function, fatigue, social support, and falls. All of these domains were predictive for at least one of the reviewed outcomes, but the results varied between the studies. Physical function and nutritional status were the most predictive domains for mortality; physical function was the most predictive domain for postoperative complications; and for chemotherapy-related outcomes, physical function and nutritional status were the most predictive domains. In conclusion, the only truly consistent finding was that physical function was the most predictive

domain of the GA for mortality, as well as for postoperative complications and for chemotherapy-related outcomes.

The reason for variation in results is the heterogeneity of the studies and study populations. First, the studies differed in study design, sample size, tumor type, and tumor stage. Second, the studies varied in the minimum age of participants: some studies also included the younger old patients (65 years or older), while other studies only included the oldest old (75 years and older). Third, the studies used different measurement tools to assess the same geriatric domain with various definitions of impairment. Finally, the studies varied in the way they reported their outcomes. Some studies reported adjusted Odds and Hazard Ratios, while others used a Chi-square test to compare the incidence of an impaired domain between the group with the outcome and the group without the outcome.

The eligible studies not only showed inconsistent results, but often also did not show a positive predictive ability of the individual domain for an oncological outcome. A reason for this null effect could be that the GA was originally not designed to predict adverse oncological outcomes but to predict functional decline and falls in an older population with cognitive and functional impairments [6]. Therefore, the used measurement tools have been validated in the traditional geriatric population instead of the oncological geriatric population. The properties of these measurement tools in oncological population may differ from

Table 2

Association of individual geriatric domain with mortality.

Outcome	Study	Cancer type	Nr of patients	Functional status		Nutrition	Cognition	Mood	Physical function	Fatigue	Social Support	Falls
				ADL	IADL							
Overall survival	Aaldriks [31]	Breast	55			++	--					
	Aaldriks [51]	Hematological	44			--	np					
	Aaldriks [8]	Various	202			++	--					
	Aaldriks [32]	Various	494			++	-					
	Aaldriks [33]	Colorectal	143			++	--					
	Biesma [68]	Lung	181	-	-		-	-	-			
	Bila [69]	Hematological	110		+							
	Clough-Gorr [41]	Breast	660					++			--	
	Ghosn [72]	Various	100	-	-	-	-	-	-			
	Girones [34]	Lung	83	-	+	+	+	+				
	Goede [30]	Hematological	75		-		+		+			-
	Hamaker [57]	Breast	78		-	np	+	+				
	Jonna [74]	Various	803	+	++		++					
	Kanesvaran [35]	Various	249	+	+	++	+	++				
	Kristjansson [36]	Colorectal	182	-	+	++	-	-				
	Merli [76]	Hematological	94	+								
	Naito [50]	Hematological	93	-	+	-	++	-				
	Ommundsen [37]	Colorectal	178	-	++	++	+	-				
	Park [38]	Hematological	70			+	-	-				
	Spina [77]	Hematological	100	+	+							
	Ugolini [27]	Colorectal	46	-	+	-	-	-	+	-		
	Wildes [78]	Breast, lung, colorectal, and lymphoma	73	-	-	-	-	-				++
1-year mortality	Brunello [42]	Various	658	--	--		--	--			--	
	Denewet [70]	Various	205	--	?	?	-	?				
	Dubruille [71]	Hematological	90	--	--	--	++	--		--		--
	Ferrat [26]	Various	993	++		+	+	+	++			
	Giantin [22]	Solid tumors	160	-	-	-	++	++				
	Hamaker [28]	Hematological	108	-	-	++	-	-	++			
6-months mortality	Hamaker [39]	Various	292	+	-	-	-	-			-	
	Marinello [75]	Breast, lung, and colorectal	110	np	-		np					
	Puts [40]	Various	112	++	-	+	-	+	-	+		
Nr of positive results/all studies (%)	Soubeyran [29]	Various	364	-	-	++	+	-	++			
				7/22 (32%)	9/23 (39%)	13/23 (57%)	11/28 (39%)	7/21 (33%)	5/8 (63%)	1/3 (33%)	0/3 (0%)	1/3 (33%)

+, significant in univariate analysis; no multivariate analysis performed or factor in multivariate analysis not significant; ++, significant in multivariate analysis; -, no association in univariate analysis; no multivariate analysis performed or factor not included in multivariate analysis; --, no association in multivariate analysis; ?, results of geriatric domain not described; np, number of compromised patients was too low: statistical analysis was not possible.

Abbreviations: ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living

Table 3

Association of individual geriatric domain with postoperative complications.

Outcome	Study	Cancer type	Nr of patients	Functional status		Nutrition	Cognition	Mood	Physical function	Fatigue	Social Support	Falls
				ADL	IADL							
Any complication <30 days	Audisio [43]	Solid tumors	460	++	+	-	-	-	-	+	-	-
	Badgwell [44]	Abdominal	111	-	-	++	-	-	-	-	-	-
	Choi [45]	Various	281	-	-	+	-	-	-	-	-	-
	Huisman [21]	Solid tumors	328	++	--	++	++	++	++	++	-	-
	Huisman [23]	Solid tumors	263	-	-	-	-	-	++	-	-	-
	Kenig [24]	Abdominal	75	?	--	--	--	--	++	?	++	-
	Kristjansson [36]	Colorectal	182	-	++	-	-	-	-	-	-	-
	Mokutani [46]	Colorectal	156	++	--	-	++	--	-	-	-	-
	Suh [25]	Gynaecological	60	-	+	-	-	-	-	-	-	-
Dependence	Baier [47]	Abdominal	200	-	--	-	-	-	-	-	-	-
Nr of positive results/all studies (%)				3/7 (43%)	3/9 (33%)	3/7 (43%)	2/9 (22%)	1/8 (13%)	3/4 (75%)	2/5 (40%)	1/1 (100%)	0/1 (0%)

+, significant in univariate analysis; no multivariate analysis performed or factor in multivariate analysis not significant; ++, significant in multivariate analysis; -, no association in univariate analysis; no multivariate analysis performed or factor not included in multivariate analysis; --, no association in multivariate analysis; ?, results of geriatric domain not described; np, number of compromised patients was too low: statistical analysis was not possible

Abbreviations: ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living

the traditional geriatric ones, because the oncological population may be faced with referral bias. The most vulnerable older patients with cancer are less likely to be referred to the oncologist. As a result, the population in the oncological setting has less functional and cognitive impairment than the population in which these tools were developed and tested.

Another reason for the null effects of the GA in predicting outcomes is the occurrence of other potential sources of bias. First, all patients were considered fit enough to undergo oncological treatment, and the decision whether a patient was eligible for chemotherapy or surgery

had already been taken, leading to selection bias. For instance, a frequently used exclusion criterion for study participation was the presence of dementia or cognitive impairment – even in studies that aimed to assess the predictive value of cognitive impairment for oncological outcomes. Another potential bias is that often the treating physician was not blinded from the outcome of the GA. Hence, the treating physician might assume that patients with an impaired GA would not be able to tolerate standard treatment, and, consequently, he might decide to offer the patient adapted oncologic treatment based on the outcome of the GA affecting the outcome. Lastly, the ceiling effects of some

Table 4

Association of individual geriatric domain with chemotherapy-related outcomes.

Outcome	Study	Cancer type	Nr of patients	Functional status		Nutrition	Cognition	Mood	Physical function	Fatigue	Social Support	Falls
				ADL	IADL							
Chemotherapy Toxicity	Aparicio [66]	Colorectal	123	-	++	-	++	-	-	-	-	-
	Baitar [67]	Various	85	?	?	?	+	?	-	-	?	-
	Bila [69]	Hematological	110	-	-	-	-	-	-	-	-	-
	Clough-Gorr [41]	Breast	660	-	-	-	-	++	-	-	++	-
	Extermann [49]	Various	518	-	-	+	+	-	-	-	-	-
	Goede [30]	Hematological	75	-	+	-	-	-	+	-	-	-
	Hamaker [73]	Breast	78	-	-	np	-	-	-	-	-	-
	Hurria [7]	Solid tumors	500	?	?	?	?	?	+	-	?	+
	Marinello [75]	Breast, lung, and colorectal	110	np	-	-	np	-	-	-	-	-
	Naito [50]	Hematological	93	-	-	+	-	-	-	-	-	-
	Puts [40]	Various	112	-	-	-	-	-	++	-	-	-
	Wildes [78]	Colorectal, lung, breast, and lymphoma	65	-	-	-	-	-	-	-	-	-
Chemotherapy Completion	Aaldriks [31]	Breast	55	-	-	--	--	-	-	-	-	-
	Aaldriks [51]	Hematological	44	-	-	++	--	-	-	-	-	-
	Aaldriks [8]	Various	202	-	-	+	+	-	-	-	-	-
	Aaldriks [32]	Various	494	-	-	++	-	-	-	-	-	-
	Aaldriks [33]	Colorectal	143	-	-	+	+	-	-	-	-	-
	Park [38]	Hematological	70	-	-	++	-	-	-	-	-	-
Functional decline after first cycle chemotherapy	Hoppe [48]	Various	364	-	++	+	+	++	+	-	-	-
Nr of positive results/all studies (%)				1/7 (14%)	3/11 (27%)	8/14 (57%)	6/17 (35%)	2/11 (18%)	4/4 (100%)	0/1 (0%)	1/3 (33%)	1/2 (50%)

+, significant in univariate analysis; no multivariate analysis performed or factor in multivariate analysis not significant; ++, significant in multivariate analysis; -, no association in univariate analysis; no multivariate analysis performed or factor not included in multivariate analysis; --, no association in multivariate analysis; ?, results of geriatric domain not described; np, number of compromised patients was too low: statistical analysis was not possible

Abbreviations: ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living

^a Better cognitive function had a higher risk for a SAE

measurements could explain the fact that only a few studies found components of the GA to be useful in predicting outcomes. The ceiling effect, as noted by Hurria et al. [52], is the effect that arises when most of the participants score the maximum score possible on a test because the test is unable to distinguish between individuals at the higher score range of the test.

This review has several strengths. We used systematic methods to select all relevant studies, and two reviewers independently assessed the selected studies on relevance and quality according to the QUIPS tool, a tool especially designed to assess the quality of prognostic studies [16,17]. In addition, no studies were excluded on the basis of quality assessment, because we have attempted to deliver a complete overview of all the current published evidence in an unbiased and reproducible way. We then provided an overview of the positive as well as the negative results. Last, we limited the selection of studies to the age cutoff of 65 years to avoid reviewing the GA domains in the “youngest old” (60–65 years) or young patients because these results may be difficult to extrapolate to our target group: the older patients with cancer (≥ 70 years or older).

This review also has several limitations. The scientific quality of the studies varied widely, and some quality criteria were not reported and consequently rated as having a high risk of bias. Another limitation might be the risk of publication bias. The literature is probably populated with positive studies that would not have been submitted or published had the results been different. Finally, in this systematic review we focused on studies assessing multiple geriatric domains as part of a GA. Studies focusing on single geriatric conditions or including multiple conditions but not labelled as geriatric assessment, may have been overlooked by our search strategy.

This is not the first systematic review assessing the predictive value of geriatric assessment. In 2012, Puts et al. were the first authors to conduct a systematic review of the use of geriatric assessment in oncology [53]. Since Puts' review was published, several systematic reviews have followed. To our knowledge, the most recent systematic reviews were published in 2015 and the authors performed their literature search in respectively September 2013 and June 2013 [13,14]. Thus a new systematic review was needed to obtain an overview of the most recent evidence, since more than half of the studies selected in our review were published in 2014 or later.

Moreover, some systematic reviews did not provide a complete overview of the current evidence for the predictive ability of the individual GA domains because they applied strict eligibility criteria. Caillet et al. [54] only selected the studies with a prospective study design, a sample size of at least 100 patients with a solid tumor, and in which the GA consisted of at least 5 GA domains. Similarly, Handforth et al. [13] and Ramjaun et al. [55] only included studies if they used a GA in which respectively three and six domains were assessed.

Three systematic reviews were published with the same aim, a similar literature search, and comparable inclusion criteria as our review. The first review, Puts et al. [53], concluded that ADL, comorbidity, and cognition were the domains consistently associated with mortality, postoperative complications, and chemotherapy-related outcomes. The second systematic review, Puts et al. [56], an update of Puts' first review, concluded that ADL, IADL, performance status, depression, and frailty were associated with poor health outcomes. The third review, Hamaker et al. [57], concluded that different conditions appeared to be predictive for the primary outcome measures and that the only consistent finding was the association between a summary score of the geriatric assessment and mortality. These findings differed from our findings for the following reasons: first, we made a clear distinction between domains that should be part of the geriatric assessment and domains that should be part of the routine oncological work-up (such as comorbidity and polypharmacy). In our opinion, comorbidity and polypharmacy should be explored in every patient, regardless of age, and therefore should not be considered part of the GA. Secondly, our

only consistent finding was the predictive ability of physical function for mortality, postoperative complications, and chemotherapy-related outcomes, whereas Puts et al. found ADL as the consistently associated domain and Hamaker et al. did not find a consistent domain at all. These different findings could be explained by the fact that our literature search was more recent. For instance, the majority of the studies including physical function in their GA were published in 2014 or later. Another explanation could be that we only selected studies reporting predictive values of the individual domains, whereas Puts et al. and Hamaker et al. also selected studies that assessed the predictive ability of geriatric domains as part of a summary score or as part of the definition of frailty.

Interestingly, no study assessed the ability of individual geriatric domains in predicting systemic treatment-related outcomes other than chemotherapy. Other systemic antitumor treatments, such as targeted therapy or immune therapy, may lead to side effects other than chemotherapy impacting the predictive ability of the individual geriatric domains.

Based on the current systematic review, we may conclude that physical function and nutritional status are the best domains to predict mortality, postoperative complications, and chemotherapy-related outcomes in older patients with cancer and therefore should certainly be included in the GA. However, whether this means that assessing the other domains is redundant is debatable. First, the content of the GA should depend on which primary outcome one wants to predict with the GA. Every geriatric domain appears to be predictive for a different oncological outcome. For example, in almost half of the studies, an impaired ADL was significantly predictive for postoperative complications. On the contrary, no study found an association between an impaired ADL and toxicity of chemotherapy. Second, because of the heterogeneity of studies, it remains questionable whether the same geriatric impairments are relevant for patient with breast cancer undergoing surgery as for a patient with lung cancer receiving palliative chemotherapy. Still, there is no consensus regarding which assessment tools and cutoff scores should be used to identify an impaired domain.

Nevertheless, in our opinion, the aim of the GA is not only to predict various outcomes, but it should be used as a tool to develop individually tailored geriatric interventions. Interventions could be based on the identified impaired GA domains to improve tolerability of the antitumor treatment, and even more important, to maintain the quality of life and the independency as much as possible. According to a review by Hamaker et al. [58], >70% of the GAs have resulted in geriatric recommendations and interventions in older patients with cancer. In the non-cancer population, the implementation of these GA-based interventions have been shown to improve a variety of outcomes, such as decreased risk of death and a decreased risk of nursing home placement [59]. Unfortunately, there has been little investigation into the benefit of GA-based interventions for the older patient with cancer. Consequently, the few RCTs that have been performed are not generalizable to daily practice, because few have been applied in a chemotherapy setting, the studies focused on one particular domain, and the studies were conducted in older patients with just one tumor type [60–65]. To our knowledge, only one recent prospective cohort study published the impact of GA-based intervention on chemotherapy tolerance in older patients with cancer. In this study, the intervention group was more likely to complete antitumor treatment and required fewer treatment modifications compared to the control group without the interference of a geriatrician [65]. Fortunately, RCTs are currently ongoing to establish whether GA-based interventions may improve the impaired geriatric domains and may result in an improved tolerability of antitumor treatment, thereby contributing to better quality of life and maintenance of independency.

In conclusion, physical function and nutritional status should be included in the GA for older patients with cancer, especially when the GA's most important aim is predicting outcomes. Nevertheless, physical function and nutritional status have not only appeared to be the

domains most predictive for our defined outcomes, but interventions to improve these domains may also be simple to implement, such as physiotherapy for muscle reinforcement in case of an impaired physical function, or referral to the dietician for advices on increasing dietary uptake or nutritional supplements in case of malnutrition. For the other domains, the findings are too inconsistent to draw conclusions about their inclusion in or exclusion from the GA with the aim to predict relevant outcomes. However, when the GA is used as a tool for optimizing care for older patients with cancer, a broad geriatric assessment is needed to identify all present impairments, serving as a base for a geriatric treatment plan as well as for geriatric follow-up.

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Appendix A. Supplementary data

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