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Cancer Rehabilitation Publications (2008–2018) With a Focus on Physical Function: A Scoping Review

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1 A Scoping Review of Cancer Rehabilitation Publications (2008-2018) With a Focus on Physical
2 Function

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1 *The views expressed do not reflect the official positions or policies of the National Institutes of*
2 *Health, the Department of Health and Human Services, or the United States Government.*

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1 **Abstract**

2 Background: Cancer rehabilitation research has accelerated over the last decade. However, closer
3 examination of the published literature reveals that the majority of this work has focused on
4 psychological interventions and cognitive and behavioral therapies. Recent initiatives have
5 aggregated expert consensus around research priorities, highlighting a dearth in research
6 regarding **measurement of and interventions** for physical function. Increasingly loud calls for
7 the need to address the myriad of physical functional impairments cancer survivors develop are
8 published in the literature. A detailed survey of the landscape of published research has not been
9 reported.

10 Purpose: This scoping review systematically identified **literature** published between 2008 and
11 2018 related to the screening, assessment and interventions associated with physical function in
12 cancer survivors.

13 Data Sources: PubMed and CINAHL searched up to September 2018.

14 Study Selection: Study selection included manuscripts of all levels of evidence on any disease
15 stage and population. 11,483 articles were screened for eligibility, 2507 full text articles were
16 reviewed with 1055 selected for final inclusion and extraction.

17 Data Extraction: Seven reviewers recorded: type of cancer, disease stage, age of subjects, phase
18 of treatment, time since diagnosis, application to physical function, study design, impairments
19 related to physical function, and measurement instruments used.

20 Limitations: Studies not written in English, study protocols, conference abstracts and
21 unpublished data were excluded.

1 Conclusions: **This review elucidates significant inconsistencies in the literature regarding:**
2 **language used to define physical function, measurement tools used to characterize function,**
3 **and the use of those tools across the cancer treatment and survivorship trajectory.** Findings
4 suggest physical function in cancer research is predominantly measured using general HRQOL
5 tools rather than more precise functional assessment tools. The authors encourage
6 interdisciplinary and clinician-researcher collaborative efforts toward a unified definition and
7 assessment of physical function.

8 Manuscript word count: (4,735/4,500 max)

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1 **Introduction**

2 More than 15.5 million Americans **have a history of cancer** and by 2026 the American
3 Cancer Society estimates that this number will increase to 20.3 million.¹ Up to 20% of childhood
4 cancer survivors and 53% of adult cancer survivors have impaired physical function²⁻⁶ **that**
5 **negatively impacts their** ability to work, participate in life roles⁷⁻¹¹ and increases their risk of
6 mortality.¹²⁻¹⁴ Despite the growing population of survivors and their demonstrably high level of
7 functional morbidity, **interventions to maintain and improve** physical function **are essentially**
8 **absent in** oncology care **outside of overt disability**.^{15,16} **Evidence clearly identifies this as a**
9 **significant gap in cancer care and suggests the need for** focused efforts to eliminate this
10 **gap**.^{15,17-19}

11 **When reviewing the literature on physical function and rehabilitation, it is evident**
12 **that a clear, consistent and universal definition is difficult to find. The most common**
13 **definition the authors came across that they believe resonates best with rehabilitation is**
14 **described by Painter and colleagues.²⁰ Painter and colleagues define physical function as**
15 **“the ability to perform the basic actions that are essential for maintaining independence**
16 **and carrying out more complex activities”.**²⁰ An individual’s level of physical functioning is
17 an essential building block to perform activities of daily living (ADLs) and instrumental
18 (IADLs).²⁰ **In order to adequately** manage physical function through the cancer continuum **it is**
19 **requisite to measure function at appropriate times during cancer care using tools that**
20 **provide insight on meaningful changes related to functional decline.** While a myriad of
21 measurement tools exist, **there is little insight on how these tools are being leveraged in**
22 **research and practice beyond just characterizing symptom burden in cancer cohorts.**
23 **Understanding the current practice of functional measurement in cancer care can provide**

1 **insight on why such substantial gaps exist in promoting adequate interventions to manage**
2 **physical function among individuals with cancer.**

3 The purpose of this scoping review **was to systematically identify literature published**
4 **between 2008 and 2018 related to the screening, assessment and interventions associated**
5 **with physical function in cancer survivors.**

6 **Methods**

7 This review follows the Transparent Reporting of Systematic Reviews and Meta-Analysis
8 (PRISMA) extension for Scoping Reviews (PRISMA-ScR) checklist and explanation.²¹

9 *Data Sources and Searches*

10 A systematic search was conducted based on the PICO format:

- 11 • *Patient:* Any individual (across the lifespan) with a current or previous oncologic
12 diagnosis,
- 13 • *Intervention:* Any study that used patient-reported or clinical measures of physical
14 function to screen, assess, or to measure an intervention outcome,
- 15 • *Comparison:* Any study that compared interventions designed to improve physical
16 function,
- 17 • *Outcomes:* Any study that reported the use of measurement tools to screen, assess, or
18 measure an intervention outcome.

19 PubMed and CINAHL Plus were searched **with the assistance of a National Institutes of**
20 **Health Biomedical Librarian** using the time period January 2008 to September 2018. Title,
21 abstract, keyword and MeSH terms were searched using the criteria are outlined in Appendix A.

1 Reference lists of all included studies and related systematic reviews were hand-searched for any
2 additional, relevant literature.

3 *Study Selection*

4 Inclusion and exclusion criteria were informed by the authors' intent to review literature
5 focused on measurement of physical function. **Physical function was defined as the ability to**
6 **perform the basic actions that are essential for maintaining independence and carrying out**
7 **more complex activities.**²⁰ Studies included were published after 2008, on a cancer population,
8 either current or prior, at any point in the lifespan, and included screening, assessment, and/or
9 intervention related to physical function. **All published literature that met these criteria were**
10 **reviewed regardless of study design. Because this was a scoping review, which is designed**
11 **to provide an overview of the existing evidence base regardless of quality, a formal**
12 **assessment regarding levels of evidence was not performed.**²² The overarching question the
13 authors considered for inclusion was the following: "Does the article provide insight on
14 **measurement tools used for screening, assessment and/or intervention related to physical**
15 **function in individuals with cancer?"** Articles were excluded if they were not available in
16 English, published prior to 2008, included pharmaceutical interventions, included non-cancer
17 populations, were non-human studies, were published protocols of ongoing trials, or did not
18 screen, assess and/or intervene for physical function. Studies of cognitive function were
19 excluded, as were studies of physiological functions or physical activity that had no clear
20 measures of physical function included in the study. Studies of female sexual function that did
21 not include a physical component such as pelvic floor muscle re-training, or movement-based
22 activity were excluded. Finally, articles that used a quality of life measurement tool that did not
23 directly assess physical function were excluded. This specifically excluded the Functional

1 Assessment of Cancer Therapy (FACT) tools as these examine physical well-being and
2 symptoms, not physical function as defined by Painter.^{20,23}

3 *Data Extraction*

4 Seven reviewers extracted data from the included studies using an electronic spreadsheet
5 with predetermined, standardized content fields. Data extracted from each article included:

6 Domains of **Functional** Measurement:

- 7 • Screening was defined as use of a measurement tool in order to identify a symptom,
8 impairment, or problem.²⁴
- 9 • Assessment was defined as use of measurement tools to provide a more in-depth,
10 multidimensional and more comprehensive way to identify the extent of an impairment or
11 functional problem.²⁴
- 12 • Intervention was defined as use of a measurement tools to measure change over time as
13 the outcome of an intervention.

14 Phase of Treatment: Prehabilitation, active cancer treatment, survivorship post active treatment,
15 palliative care

16 Populations: Pediatric <18, Adult 18-65, Geriatric >65

17 Stage of Disease: 0-III, All Stages, Metastatic

18 Time Since Diagnosis: <1 year, 1-5 years, >5 years

19 Type of Study: Case Study, Editorial or Commentary, Narrative Review, Systematic
20 Review/Meta-Analysis, Observational trials, Controlled trials

21 Interval of Measurement: Cross-sectional, Pre-test/Post-test, Repeated Intervals

22 Measurement Tools Used: Comprehensive list of all measurement tools used in the study that
23 were specific to physical function.

1 If there was a discrepancy in the extracted data, the full-text article was re-examined by two
2 independent reviewers to arrive at a consensus. No formal quality assessment of individual
3 manuscripts was undertaken following standard practice for scoping reviews.²⁵

4 *Data Synthesis and Analysis*

5 Descriptive data extracted under the coded categories were analyzed quantitatively
6 through summary counts in Microsoft Excel and Tableau. Data was aggregated for analysis
7 based on the study's primary application of physical function measures: screening, assessment,
8 or intervention and the results are presented by these three domains.

9 **Results**

10 The search identified 11,479 articles following the removal of duplicates. After initial
11 screening of titles and abstracts, 2,507 references underwent full text review, and 1,055 articles
12 were included (Supplemental Figure 1). Approximately one-third of the articles included patients
13 with various cancer diagnoses (30.3%), while the rest focused on a single cancer, most
14 commonly breast (24.8%) and hematological (8.6%). (Table 1) Of the trials, 86% included
15 participants who received some combination of antineoplastic therapies (surgery, chemotherapy,
16 radiation therapy, and/or hormonal treatments). Of the studies that reported disease stage
17 (n=650), 11.1% focused on metastatic populations.

18 *Phase of Treatment*

19 Most articles (77%) measured physical function following the completion of active
20 cancer treatment. Only 16% featured the active cancer treatment phase, and 0.3% were palliative
21 care. Prehabilitation phase, prior to onset of cancer treatments, was highlighted in 2.6% of the
22 studies including seven in lung cancer and six in colorectal cancer (Table 1). Prehabilitation
23 studies that screened physical function most commonly used broad oncologic-based performance

1 status measures such as Karnofsky Performance Scale (KPS) and the Eastern Cooperative
2 Oncology Group (ECOG) performance measure. Alternatively, a number of prehabilitation
3 studies measured changes in cardiorespiratory fitness, and (ADL)/(IADL) with more specific
4 measures over the duration of a rehabilitative intervention designed to prepare subjects for their
5 pending antineoplastic therapies. (Supplemental Table 1)

6 Of 171 studies focused on physical function during active cancer treatments, 13 (7.6%)
7 targeted geriatric populations, most commonly prostate cancer, and 16 (9.4%) were pediatric
8 typically hematologic cancers. (Table 1). Few were undertaken during an isolated cancer
9 therapy; 0.2% radiation, 1% chemotherapy, and 0.6% hormonal therapy. In these instances,
10 functional endpoints measured the impact of treatment side effects (e.g. neuropathy, fatigue, joint
11 arthralgias) or of an intervention, targeting side effects of treatment (e.g. exercise for fatigue or
12 loss of lean mass).

13 Most (64%) of the 814 studies of survivorship after active cancer treatment were in the
14 assessment domain, and 64% of those implemented a cross-sectional design to characterize the
15 functional impact of various cancer treatments and side effects on the individual (Supplemental
16 Table 1). Studies classified as screening were primarily observational (69%) that used survey
17 data from a larger ongoing study, obtained retrospective data on physical functional measures, or
18 surveyed a population to assess physical function. One hundred and twenty-eight controlled
19 trials were conducted, post-active cancer treatment, with 75% of those being intervention trials.
20 Of studies that reported time since diagnosis, (n=610) 45.5% were conducted on populations > 5
21 years post completion of cancer treatments, 34.5% were within 1-5 years of treatment and 20%
22 were <1 year from diagnosis. (Supplemental Table 1)

23 *Age Group of Interest*

1 The most frequently studied age group (80%) was adults over 18 years, while 9.1% of
2 studies focused on geriatrics (>65 years old), and 6.5% (n=69) on pediatrics (<18 years old)
3 (Table 1). Of the adult studies, 4.8% (n=40) highlighted childhood cancer survivors. The
4 geriatric studies were primarily (41%) breast or prostate cancer but 25% included a variety of
5 cancer types. Studies focused on geriatric and pediatric populations routinely utilized age-
6 specific functional measures. (e.g. Pediatric Quality of Life Inventory (PedsQOL),
7 Comprehensive Geriatric Assessment)

8 *Domain of Measurement Application and Functional Measurement Tools*

9 Of the included studies, 61.5% assessed physical function, 19.5% screened for
10 impairment, and 19.0% applied functional tools to measure effectiveness of an intervention.
11 Figures 1-3 illustrate the most used tools by type of cancer, for each of the three application
12 domains. The SF-36 was the most frequently used measure for screening (n=39), assessment
13 (n=186) and intervention (n=57). Across all three domains, the most commonly used measures of
14 physical function were SF-36 (29%), the European Organization for Research and Treatment of
15 Cancer Quality of Life Questionnaire-Cancer 30 (EORTC QLQ-30) (21.5%), specific symptom-
16 based modules of the EORTC (10%), the 6-minute walk test (6MWT) (7.4%), and ‘other self-
17 developed tools’ (13%). The latter term describes tools or surveys developed by authors for their
18 own use.

19 *Impairment Findings*

20 Impairment data were extracted from controlled trials, observational studies, narrative
21 and systematic reviews. Up to five impairments (if applicable) and all measurement tools, were
22 extracted for each article. However, due to the magnitude of data extracted in this scoping

1 review, we elected to only report on primary and secondary impairments identified and the first
2 three measurement tools reported in each study (Table 2). (The reader can review online
3 supplementary tables for the full data set). The most frequently measured physical impairments
4 were Health-Related Quality of Life (HRQOL), ADL/IADL/Extended IADLs, swallowing and
5 speech, incontinence, cardiorespiratory fitness, weakness, sexual function, and cancer-treatment
6 symptoms (pain, fatigue, lymphedema, and neuropathy).

7 Table 2 provides a detailed breakdown of the top three measurement tools identified in
8 studies based on type of cancer and the primary and secondary impairments. Although reviewers
9 extracted up to 5 impairments from each study and characterized all of the measurement tools
10 used within a study, only the primary and secondary impairments, and top three measurement
11 tools are presented, with the remainder of the material available in supplemental files on-line.

12 Table 2 shows the combination of measures by impairments and reveals that specific
13 impairment-based measurement tools (measures of balance, swallowing, and incontinence) were
14 frequently combined with more generic tools like SF-36 or EORTC, likely to characterize a
15 specific impairment in greater detail than these general tools allow. The on-line supplemental
16 table characterize the number of different tools used for impairment measurement.

17 **Discussion**

18 To our knowledge, this is the first scoping review on measurement of physical function in
19 individuals who have or have had cancer. Results suggest that in cancer research, physical
20 function is predominantly measured using general HRQOL tools rather than more precise
21 functional assessment tools. Further, results point to inconsistencies in language used to describe
22 physical function, measurement tools used to characterize function, and application of those tools
23 across the cancer treatment and survivorship trajectory. No universally accepted operational

1 definition of physical function was identified. Each gap revealed by this scoping review is also a
2 research and practice opportunity with potential to improve the measurement and management of
3 physical function in interprofessional cancer care. (Table 3)

4 **Opportunity: Assess function prospectively from a pre-treatment baseline**

5 In the articles reviewed, physical function assessment was overwhelmingly cross-
6 sectional and occurred well into the post-treatment survivorship phase with >45 % of studies
7 taking place > 5 years post treatment completion. Post-treatment functional status is important,
8 but difficult to interpret without a pre-treatment baseline, or a matched cancer- or treatment-free
9 comparison group. This highlights one of the most significant gaps in current evidence and
10 practice; prospective assessment of functional changes from a pre-treatment baseline.

11 Cancer treatment-related functional problems are under-identified and under-treated.²⁶
12 Less than 2% of individuals who present with clinically-identifiable functional limitations are
13 referred for rehabilitation services to manage these limitations.^{16,27} In the absence of
14 rehabilitation, conditions like cancer-related fatigue, lymphedema, and chemotherapy-induced
15 peripheral neuropathy (CIPN) may lead to life-long disability.^{28,29} Many treatment-induced
16 impairments that contribute to functional decline during cancer treatment are amenable to
17 rehabilitation. When intervention is implemented early in the oncology care plan, physical
18 impairments can be effectively managed to prevent or mitigate functional decline.^{27,30}
19 Theoretical models that promote proactive functional assessment and interventions to maximize
20 function, leveraging rehabilitation professionals, were common among narrative reviews and
21 commentary articles in our results,^{27,31,32} however controlled trials testing such models were rare.

22 Cancer rehabilitation prospective surveillance models were first published nearly a
23 decade ago yet they are not the clinical standard of care, even for cancers (breast, head and neck)

1 with well-documented and predictable neuromusculoskeletal impairments.³³⁻³⁶ The clinical goals
2 of prospective models are to repeatedly screen and educate at routine intervals during cancer
3 treatment to facilitate early identification and intervention to mitigate or even prevent functional
4 decline.^{32,36} Early identification and management of symptoms does more than support survivors;
5 recent findings suggest that lifespan is extended when supportive care begins at the time of an
6 advanced cancer diagnosis.^{37,38}

7 Baseline functional assessment can also assist medical, surgical, and radiation oncology
8 teams as they prescribe life-extending cancer therapies. Often, patients are refused optimal
9 cancer therapeutics based on a provider's subjective appraisal of their physical performance.
10 Using specific patient-reported tools and clinical performance tests may support more accurate
11 classification of physical function enabling greater precision in oncologic treatment planning.^{39,40}
12 The model for baseline functional assessment also enables prehabilitation interventions for those
13 individuals who fall in 'borderline' categories for physical tolerance to cancer therapies and may
14 enable them to jump to the 'fit for treatment' category.

15 As a research opportunity, prospective assessment would provide historical comparison
16 data for the natural history of functional change during cancer treatment, the absence of which
17 confounds discussions of how to achieve optimal long-term survivorship.⁴¹ Data on proactive
18 functional changes through cancer treatment can support delivery of exercise and rehabilitative
19 interventions of the most appropriate intensity in the least restrictive environment to promote
20 function. Evidence is rapidly growing to support the predictive and prognostic value of baseline
21 physical function on cancer outcomes, ranging from reduced surgical complications to overall
22 survival.^{42,43} Experts have identified physical function as an emerging prognostic biomarker in

1 cancer.⁴⁴ Ample opportunity exists to further explore physical function as a prognostic
2 biomarker, as there is no single ‘gold standard’ physical function metric.

3 **Opportunity: Identify predictive and informative transdisciplinary tools**

4 While patient-reported and **performance measures** were both identified, our scoping
5 review results are clear: physical function was more commonly assessed through patient report
6 than by actual measurement of physical performance, and the resulting characterization of
7 function was largely based on subscales of larger HRQOL measures. An optimal tool predicts
8 meaningful outcomes, informs the specific nature of a survivor’s functional decline and detects
9 meaningful changes that necessitate triage for intervention. This review identified a
10 preponderance of non-specific tools applied for both screening and assessment of physical
11 function; we suspect this is a key factor leading to the relative under-reporting and under-
12 treatment of cancer-related functional problems.

13 ***Patient-reported measures***

14 The most frequently used scale to measure physical function was the non-specific SF-36,
15 followed by the cancer-specific EORTC and its site- and symptom-specific derivations. These
16 measures primarily capture HRQOL, but the physical function scales offer a limited assessment
17 of the broad range of extended ADLs. Furthermore, these tools may not be responsive to
18 measuring functional change over time.⁴⁵

19 Likely because it is newer, the Patient Reported Outcomes Measurement System
20 (PROMIS) measures were rarely identified among the articles reviewed. PROMIS uses a
21 computer-adapted technology (CAT) format with follow-up questions offered or withheld based
22 on the answer to a ‘stem’ and accommodates individual patient responses. PROMIS offers

1 greater responsiveness with less burden.⁴⁶ A set of PROMIS tools are specifically designed and
2 validated for cancer populations.⁴⁷ Another CAT functional assessment tool, the Activity
3 Measure- Post Acute Care (AM-PAC) is being tested in prospective surveillance trials.^{48,49} These
4 individualized tools may provide greater specificity in functional assessment in the future.

5 ***Performance measures***

6 Performance measures commonly used in oncology care, such as the ECOG or KPS, are
7 based on provider observation and lack specificity in functional assessment. Although these
8 scales provide a quantitative score, they are not informed by objective or quantifiable measures
9 of performance. Recent reviews in geriatric oncology identify shortcomings in these tool's
10 ability to accurately identify important and emerging functional changes, challenging their
11 specificity as compared to a more comprehensive battery of tests.^{50,51}

12 Clinical performance measures reported in this review ranged from the Timed up and Go.
13 (TUG) and 6MWT, to more comprehensive assessments like the Short Physical Performance
14 Battery (SPPB). Questions exist regarding the responsiveness of some tools like the Timed Up
15 and Go (TUG) and the AM-PAC, which were validated in disabled populations outside of
16 oncology. Their use in oncologic populations, specifically the potential for ceiling effects when
17 applied to higher functioning cohorts, is concerning considering the wide variability in
18 impairment severity that an individual can experience through cancer care.^{52,53} Many individuals
19 express self-reported concerns about physical function below their personal baseline, or 'normal'
20 even when their clinical measures improve.⁵³ Reconciling discordant patient-reported measures
21 and clinical performance measures is a documented challenge.⁵²

22 Identifying an optimal interdisciplinary tool valid across diverse cancer populations will
23 prove challenging, especially one that can meet a range of needs across the lifespan.

1 Increasingly, validated scales that serve multiple needs in similar populations are often batteries
2 of tests.⁵⁴ The geriatric assessment (GA) for cancer survivors is now well-validated battery of
3 tests and includes a physical performance test (TUG) to supplement patient-report, but as
4 intended, its validation has been limited to older adults.^{55,56} Moreover, ADLs and IADLs are
5 increasingly supported in the literature as predictors of meaningful cancer outcomes specifically
6 in breast and prostate cancers.⁵⁷⁻⁵⁹ Performance assessment batteries⁶⁰ fit well within the
7 expertise of rehabilitation providers, yet our scoping review suggests that IADLs are currently
8 captured primarily by patient-report, perhaps for feasibility.

9 Interestingly, recent evidence suggests that gait speed, as a single performance-based
10 measure of function mobility, is almost as useful as larger batteries like the comprehensive GA
11 yet is less burdensome and more clinically feasible.⁶¹ As a single performance measure valid for
12 both risk stratification and outcomes assessment, gait speed is one of the physical function tools
13 validated in oncologic populations^{53,62} and correlates well with other performance measures
14 (6MWT, TUG).⁶³

15 Identifying a single tool capable of capturing all domains of physical function across the
16 cancer experience (pre-morbid status, cancer site, cancer stage, and the highly individualized
17 response to treatments), and applicable to all disciplines within cancer rehabilitation, will be no
18 small task. Emphasis should initially be placed on studying the construct of repeated measures
19 and these tools' responsiveness to functional change. Future research endeavors can then explore
20 effective combinations of measures based on an individual presentation. This patient-specific
21 approach is being championed by policy makers in oncology care delivery.⁶⁴

22 **Opportunity: Selective assessment of single antineoplastic modalities or regimens**

1 In over 80% of articles reviewed, patients had received multiple cancer treatment
2 modalities (e.g. surgery, radiation and chemotherapy). This is likely due to the propensity of
3 cross-sectional assessments conducted long after treatment ended. While these studies provide
4 insight on the incidence of late effects, they fail to characterize mechanisms for functional
5 decline based on single treatment modalities. More selective prospective observation, with pre-
6 treatment baseline, would inform the critical knowledge gap of mechanisms behind physical
7 function declines, by specific cancer population and treatment regimen. For example, CIPN is
8 known to negatively impact ADL's and functional mobility due to sensory, proprioceptive, and
9 motor deficits. Functional measures taken before and during the delivery of neurotoxic
10 chemotherapy agents may facilitate triage for rehabilitative interventions that can mitigate
11 functional decline.⁶⁵ Some specificity of functional measures to guide intervention was identified
12 around the perioperative time period, primarily in breast cancer and targeting restoration of upper
13 extremity mobility. The premise that surgery incites functional deficits which require
14 rehabilitative interventions is well regarded.⁶⁶⁻⁶⁸ There is merit to carrying this rationale over to
15 chemotherapy, radiotherapy, and hormonal therapy as the morbidity burden is equally, if not
16 more, important in context to the treatment rendered.

17 **Opportunity: Align semantics for concise and precise functional assessment.**

18 Inconsistencies in language and terminology are notable across the studies in this review.
19 Perhaps this relates to the lack of a universally accepted definition of physical function. The
20 semantic variations present a conflict when attempting to look across studies and draw
21 conclusions on optimal approaches to measure and manage physical function.

22 ***Physiologic Function vs Body Structure and Function***

1 We identified significant variance in the clinical measures used and their extrapolations
2 as a reflection of functional status. One prominent conflict was physiological functions (e.g.
3 cardiac ejection fraction, VO2 max, pulmonary expiratory volume) and measures of body
4 structures and functions (e.g. joint range of motion, muscle power, muscle strength) assessed as
5 proxies for overall physical functioning. While measures of physiologic function, or of body
6 structures and functions, provide insight on the components of body systems, they fail to assess
7 how the individual performs activities and participates in daily life.

8 ***Physical Activity vs Physical Function***

9 Some articles purporting to measure physical function actually assessed levels of physical
10 activity. To some extent, *whether* an individual chooses to be active and participate may speak
11 to their *ability* to be active and participate. While physical activity prominently features in
12 observational studies^{12,69} and changes in physical activity levels correlate to cancer disease end
13 points, more detailed assessment of how physical function impacts physical activity levels
14 should be explored as these are two different constructs. Promoting physical activity is a
15 mainstay of cancer control science, however without perspective on the physical function of
16 cancer survivors there may be a critical piece missing in the rationale for population approaches
17 to encouraging physical activity. Physical impairment introduces barriers to achieving optimal
18 levels of physical activity. Clearly delineating between these constructs yet elucidating on their
19 dependent relationship is a need.

20 ***Body Structure and Function vs. Activities and Participation***

21 While there is an intimate relationship between body structures and functions, and
22 activities and participation, measures of function in life roles is the most relevant measure of
23 ability or disability. Individuals may be severely incapacitated in body structure and functions (e.g.

1 an individual with multiple limb loss), but still able to function in life roles at a high level with
2 supportive services and devices. Therefore, gross measures of impairment such as joint ROM,
3 oxygen consumption, and limb volume may minimally reflect an individual's ability to
4 participate in life roles. For example, an individual with severe lymphedema may still carry out
5 self-care strategies independently with modifications. While impairment severity is highly
6 relevant to a plan of care that improves activities and participation, solely assessing the severity
7 of one or more impairment in an inadequate measure of function.

8 **Future Recommendations**

9 Achieving an interval prospective surveillance approach that seeks to optimize physical
10 function in oncology will require:

11 **1. Reliable, predictive, and responsive measures of physical function. A variety of patient-**
12 **reported and clinical measures are reported in the literature that examine function,**
13 **however many of these lack reported psychometric properties specific to the cancer**
14 **population.⁷⁰⁻⁷² Additionally, little is known regarding what objective measures of function**
15 **may predict changes in specific symptoms related to cancer. Future studies should**
16 **incorporate both patient-reported outcomes as well as objective measures that have sound**
17 **psychometrics in the cancer population in order to identify functional deficits that are of**
18 **primary concern to individuals with cancer and may result in symptom interference with**
19 **functional activities.**

20 **2. A framework for proactive, repeated functional measurement** through the duration of
21 cancer treatments to periodically re-assess risk for, or presence of, clinically meaningful changes
22 in function. Achieving this aim will require a clear definition of physical function, a rigorous

1 and reproducible assessment protocol, and a pathway to clinical implementation that allows for
2 flexibility in the framework based on the individual, their cancer type and anticipated treatments;

3 **3. Clinical pathways to facilitate triage into rehabilitation systems**, promoting proactive
4 interventions to optimize function throughout the cancer trajectory. This approach not only
5 positively impacts an individual's function during cancer treatment but promotes optimal long-
6 term function in this population.⁴¹

7 **Limitations of this Scoping Review**

8 We recognize many limitations inherent to this scoping review. Most importantly, we
9 urge readers to interpret the findings with attention to the methods used in this literature search
10 and data extraction. After careful discussion, the extraction team applied Painter's published
11 definition of physical function²⁰, but individual interpretation occurs even within a seemingly
12 clear definition. Article selection, initially by review of abstracts and then full text, required
13 concordance from two reviewers, but there was some opportunity for inter-rater deviation on key
14 variables during the extraction process.

15 The operational definitions used in this scoping review are more specific to physical
16 function than prevailing practice in oncology. While this was intentional to elucidate the gaps in
17 physical function measures, common practice in clinical trials actually supports the use of non-
18 specific HRQOL tools in clinical trials.

19 The sheer volume of articles included in this scoping review presented another limitation.
20 Processing over 7,000 initial hits required significant time from the authorship team, making it
21 impossible to include newly released articles, yet we recognize that publications on this topic are
22 growing exponentially. New publications may counter some of our conclusions by the time of

1 publication. Additionally, while the results are intended for application to the diverse disciplines
2 of cancer rehabilitation, all authors are physical therapists.

3 Lastly, we did not assess the feasibility of functional measurement nor reports of the rates
4 of complete or missing functional data in trials. Time burden is a recognized issue for patients
5 being asked to complete these tests and assessments. As well, providers experience a time burden
6 in administering, interpreting, and determining a plan of care based on these tests. Closer
7 examination of feasibility and models for implementation of a functional framework are needed.

8 **Conclusion**

9 In summary, this scoping review, the first of its nature, adds to the literature on physical
10 function over the cancer trajectory and across the lifespan. Functional decline is prevalent in
11 individuals diagnosed with cancer, both during and after cancer treatments. Functional morbidity
12 may drive the psychological and emotional issues faced by persons with cancer. Functional loss
13 too often goes undetected until severe. Results of this scoping review suggest that one
14 contributor is a lack of consensus about a single physical function definition, and best measures
15 of physical function. While it is clear that both the ECOG and KPS lack the specificity to
16 measure discrete limitations in physical function, and fall short of prompting triggers for triage to
17 rehabilitation, we are unable to promote a single tool or assessment battery as a physical function
18 ‘gold standard’ based on results of this review. Research opportunities are vast.

19 The authorship team encourages interdisciplinary and clinician-researcher collaborative
20 efforts toward a unified definition and assessment of physical function, one appropriate for both
21 cancer rehabilitation research and practice. Such efforts should consider current needs for
22 evidence behind (1) baseline assessment for optimal risk-stratification to inform triage for
23 prehabilitation, but also immediate cancer treatment prescription, (2) prospective surveillance to

1 capture earliest decline, and (3) outcomes to measure effectiveness of cancer rehabilitation
2 interventions and preventions. We encourage the use of measurement tools specific to activity
3 and participation, and the broad assessment of physical function, beyond physiological tests and
4 measures that may or may not correlate with overall function. It is likely that no single, static
5 battery will meet all screening, assessment, and intervention needs in the diverse field of cancer
6 rehabilitation, across the lifespan, and along the cancer trajectory from diagnosis to late
7 survivorship. Even so, settling on a universal definition of physical function is a critical first
8 step.

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1 Table 1. Descriptive Data

CANCER TYPE	n	%
Bladder	5	0.5
Breast	262	24.8
Brain	38	3.6
Colon	54	5.2
Gynecological	58	5.5
Head and Neck	66	6.3
Hematological	91	8.6
Lung	25	2.4
Sarcoma	29	2.8
Other GI*	21	2.0
Prostate	64	6.1
Various**	320	30.3
Melanoma	7	0.7
Testicular	5	0.5
Other cancers	11	1.0
***Adult Survivors of Childhood Cancer	40	4.8
Disease Stage	n	%
0-III	467	44.4%
All Stages	109	10.3%
Not Reported	406	38.4%

Metastatic(IV+)	73	6.9%
Phase of Treatment	n	%
Prehabilitation	28	2.6
Active cancer treatment	171	16.2
Survivorship post-active cancer treatment	814	77.1
Palliative Treatment	4	0.4
Population	n	%
Adult >18	842	79.8
Pediatric <18	69	6.5
Geriatric >65	97	9.2
Not reported	46	4.4
Domain	n	%
Screening	206	19.5
Assessment	648	61.4
Intervention	200	18.9
Study Type	n	%
Case Report	17	1.6
Editorial	32	3.0

Narrative Review	103	9.7
Controlled Trials	347	32.9
Systematic Reviews	85	8.1
Observational Studies	472	44.7

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Table 2. Breakout of measurement tools in the domains of Screening, Assessment, and Intervention

SCREENING FOR PHYSICAL FUNCTION				
Most Frequently Reported Tools (> 5 studies)*	Tool	(n)		
	Short Form-36 (SF-36)	59		
	European Organization for Research & Treatment of Cancer Quality of Life Questionnaire-Cancer 30 (EORTC QLC-C30)	48		
	EORTC Modules	30		
	Other self-developed tools	43		
	Common Terminology Criteria for Adverse Events (CTCAE)	23		
	Eastern Cooperative Oncology Group (ECOG)	17		
	Pain Visual Analog Scale (VAS)	17		
	Comprehensive geriatric assessment	15		
	Fatigue VAS	15		
	Timed Up & Go (TUG)	13		
	MD Anderson Dysphagia Inventory (MDADI)	10		
	Karnofsky Performance Status (KPS)	9		
	Distress Thermometer	9		
	EuroQol instrument-5 Dimensional (EQ-5D)	8		
	University of Washington-Quality of Life (UW-QOL)	8		
	Expanded Prostate Cancer Index Composite (EPIC-26)	7		
	Pediatric Quality of Life Inventory (PedsQL)	7		
	Short Form-12 (SF-12)	7		
	Six-minute walk test (6MWT)	6		
Type of cancer	Impairments (Primary and Secondary)	Measurement tools 1	Measurement tools 2	Measurement tools 3

Brain	ADL/IADL/Extended IADLs		Karnofsky Performance Scale (KPS)	Eastern Cooperative Oncology Group (ECOG) Performance scale		
	HRQOL	ADL/IADL/ Extended IADLs	EORTC QLQ-C30	EORTC Modules	MD Anderson Symptom Inventory	
Breast	ADL/IADL/Extended IADLs		Life Satisfaction Questionnaire-11 (LiSat-11)	Other self-developed tools		
	Fatigue	HRQOL	SF-36	ECOG		
		Pain	Therapy-Related Symptom Checklist (TRSC)	Linear Analogue Self-assessment (LASA)	Daily Activities Rating Scale (DARS)	
	HRQOL	EORTC QLQ-C30		SF-36		
		Health Utilities Index		SF-36		
		Other self-developed tools		EORTC QLQ-C30	SF-36	
		SF-36				
				ECOG		
		World Health Organization Quality of Life-100 (WHOQOL-100)		EORTC Modules		
		ADL/IADL/ Extended IADLs		EORTC QLQ-C30	EORTC Modules	
		Fatigue		EORTC QLQ-C30	EORTC Modules	Fatigue Visual Analog Scale (VAS) Other self-developed tools
	Sexual Function		General Health Questionnaire (GHQ)	SF-36	Watts Sexual Function Questionnaire*	
	Lymphedema	ADL/IADL/ Extended IADLs		Lymphedema Symptom Intensity and Distress Survey-Arm (LSIDS-A)		
				Water displacement	Pain VAS Arm symptom VAS*	
		HRQOL		EORTC QLQ-C30	EORTC Modules	Water displacement
		Upper Limb Function		Upper Extremity Functional Index (UEFI)	QuickDASH	Pain VAS
Pain		AROM	Swelling	QuickDASH*		

	Neuropathy	ADL/IADL/ Extended IADLs	Neurotoxicity score	ECOG	SF-36	
	Return to Work		Self-focused Emotional Labor Scale	Work Ability Index	Work Limitations Questionnaire*	
	Pain	ADL/IADL/ Extended IADLs	Brief Pain Inventory (BPI)	WOMAC Index	DASH*	
			SF-36	Pain VAS		
	Cardiorespiratory Fitness		SF-36	TUG	30 Second Sit to Stand	
	Sexual Function	HRQOL	Pelvic Floor Distress Inventory	ECOG		
Colon	HRQOL		EORTC QLQ-C30	EORTC Modules		
				ECOG		
			ADL/IADL/ Extended IADLs	SF-36	ECOG	
			Fatigue	EORTC QLQ-C30	EORTC Modules	
	Neuropathy			EORTC Modules	ECOG	Total Neuropathy Score
			Fatigue	Other self-developed tools	Fatigue VAS	
			HRQOL	Common Toxicity Criteria for Adverse Events v3	Total Neuropathy Score	World Health Organization QOL scale*
Gynecological	ADL/IADL/Extended IADLs		ECOG			
			World Health Organization International Classification of Function (WHO ICF)	Other self-developed tools		
	Fatigue	HRQOL	Fatigue Questionnaire	Patient Health Questionnaire-9	EORTC QLQ-C30*	
			Fatigue VAS	Other self-developed tools		
	Fecal Incontinence		Other self-developed tools	Fecal Incontinence Severity Index		
	HRQOL	Fatigue	EORTC QLQ-C30	SF-36		
			SF-36			
			Pain	KPS	EORTC QLQ-C30	

	Neuropathy	Balance	Chemotherapy-induced peripheral neuropathy assessment tool (CIPNAT)	TUG	Fullerton Advanced Balance (FAB)	
		HRQOL	Other self-developed tools	ECOG		
	Cardiorespiratory Fitness		VO2peak	Fatigue VAS		
	Sexual Function	Fatigue	EORTC QLQ-C30	CALGB sexual functioning scale	Other self-developed tools	
		HRQOL	KPS	Fatigue Symptom Inventory Revised (FSI TDI)	SF-12*	
	Urinary Incontinence	Fecal Incontinence	ECOG			
			Incontinence Severity Index questionnaire	Questionnaire for Urinary Incontinence Diagnosis (qUID)	Fecal Incontinence Severity Index*	
	Head and Neck	ADL/IADL/Extended IADLs		EORTC QLQ-C30	EORTC Modules	University of Washington Quality of Life Score (UW-QOL)
		Fatigue	Pain	Distress Thermometer		
		HRQOL		EORTC QLQ-C30	EORTC Modules	N-35
Other self-developed tools						
Other self-developed tools				EORTC Modules	EORTC QLQ-C30	
PSS-HN				XeQOLs	EQ-5D-3L	
SF-36				EORTC QLQ-C30	EORTC Modules*	
UW-QOL						
ADL/IADL/ Extended IADLs				6MWT	30-sec Chair Stands	Push-up Test
Joint Mobility				EORTC QLQ-C30	EORTC Modules	
Speech and swallowing		UW-QOL	MD Anderson Dysphagia Inventory (MDADI)			
Pain		SF-36				
Joint Mobility		Speech and swallowing	Penetration and Aspiration Scale	Functional Oral Intake Scale	Therabite ROM scale*	

	Speech and swallowing		Brief ICF Core Set for HNC	BCSQ-H&N	UW-QOL
			MD Anderson Dysphagia Inventory		
				Fiberoptic Endoscopic Evaluation of Swallowing (FEES)	Swallowing performance using water swallow test
			Other self-developed tools	Vanderbilt Head and Neck Symptom Survey version 2.0 (VHNSS 2.0)	
Hematological	ADL/IADL/Extended IADLs		Pain VAS	ROM	
			Pain	Health Utilities Index Mark 3 (HUI3)	Pain VAS
	Balance		Bruininks-Oseresky Test of Motor Performance (BOT-2)	Movement assessment battery for children version 2 (MABC-II)	University of Quebec in Chicoutimi-University of Quebec in Montreal (UQAC-UQAM)*
		ADL/IADL/ Extended IADLs	Ankle tendon reflexes	Sensory Organization Test (SOT)	TUG
	Cardiorespiratory Fitness		6MWT		
		HRQOL	SF-36	EuroQol EQ-5D	
	Fatigue		Fatigue Questionnaire	SF-36	
		HRQOL	Fatigue Questionnaire	SF-36	Other self-developed tools
		Pain	SF-36	Rotterdam Symptom Checklist (RSCL)	
	HRQOL	Fatigue	Lee Chronic Graft V Host Disease Symptom Score	Self-assessed Karnofsky performance status	Other self-developed tools
		Pain	SF-36	EuroQol EQ-5D	Global rating scale
				Other self-developed tools	
	Neuropathy		Neuropathy Impairment Score	Total Neuropathy Score	Bruininks-Oseretsky test of Motor Proficiency- Short Form (BOT-2)*
Lung	ADL/IADL/Extended IADLs	Fatigue	EORTC QLQ-C30	EORTC Modules	Other self-developed tools
	Fatigue	Cardiorespiratory Fitness	Brief Fatigue Inventory (BFI)	Perceived Self-Efficacy for Fatigue Self-Management	Activity Specific Balance Confidence Scale

	HRQOL		EORTC QLQ-C30	EORTC Modules	
		ADL/IADL/ Extended IADLs	SF-36	EORTC QLQ-C30	Other self-developed tools
		Cardiorespiratory Fitness	SF-36	dyspnea index	BPI *
Melanoma	ADL/IADL/Extended IADLs	Weakness	ECOG		
Other GI	ADL/IADL/Extended IADLs		Balducci ADL score	ECOG	Cumulative Illness Rating Scale Geriatrics (CIRS-G)
	Fecal Incontinence	Sexual Function	City of Hope Quality of Life-Colorectal Cancer (COHQOL)		
			Memorial Sloan-Kettering Cancer Centre (MSKCC) Bowel Function Instrument	EORTC QLQ-C30	EORTC Modules
	HRQOL	Fatigue	EORTC QLQ-C30		
Pain VAS				Fatigue VAS	
Pediatric Brain Tumor	ADL/IADL/Extended IADLs		Other self-developed tools		
	Fatigue	Pain	None reported		
	HRQOL		PedsQL		
			SF-36	Health Utilities Index Mark 3	Child Health Questionnaire*
Prostate	Fatigue	Pain	Fatigue Questionnaire	Brief Sexual Function Inventory	Short Form-12* (SF-12)
	HRQOL		Patient-Reported Outcomes Measurement Information System (PROMIS)		
			Pain	EORTC QLQ-C30	EORTC Modules
			Sexual Function	Expanded Prostate Cancer Index Composite (EPIC-26)	
			SF-36	UCLA-Prostate Cancer Index (UCLA-PCI)	KPS
			Urinary Incontinence	Health Utilities index	Patient Oriented Prostate Utility Scale

			SF-36	UCLA-PCI	
	Sexual Function	Urinary Incontinence	EORTC QLQ-C30	EORTC Modules	
			EPIC-26		
			Other self-developed tools	Attitudes and Practice Survey	
	Urinary Incontinence	Fecal Incontinence	SF-12	Brief Sexual Function Inventory	EPIC*
Sarcoma	HRQOL		Toronto Extremity Salvage Score (TESS)	PedsQL	Other self-developed tools
Various	ADL/IADL/Extended IADLs		ECOG	KPS	
			Medical Expenditures Panel Survey (MEPS)		
			Musculoskeletal Tumor Society Scale (MSTS)		
			Other self-developed tools	ECOG	
				Sit to stand	
			SF-36	Other self-developed tools	
		Fatigue	EORTC QLQ-C30	EORTC Modules	
			SF-36	BFI	
		HRQOL	Other self-developed tools	Sit to stand	Satisfaction with Life Scale
		Pain	EQ-5D-5L	Other self-developed tools	
			SF-36	Pain VAS	Other self-developed tools
	Balance	ADL/IADL/ Extended IADLs	SF-36		
	Cardiorespiratory Fitness		Comprehensive geriatric assessment	TUG	Gait speed
	Fatigue		BFI	EORTC QLQ-C30	Fatigue Severity Scale*
	HRQOL	EORTC QLQ-C30	EORTC Modules		
	Weakness	TUG	Peak isometric knee extension force		
HRQOL		Other self-developed tools	SF-36		
		PedsQL	Health Utilities Index Mark 3	Child Health Questionnaire*	

		SF-12	Brief Symptom Inventory 18 (BSI-18)	Other self-developed tools
		SF-36		
			15D (15 dimensions)	
			Impact of cancer questionnaire	City of Hope QOL-Cancer Survivors
		SF-12		
	ADL/IADL/ Extended IADLs	Functional Living Index-Cancer	Rotterdam Symptom Checklist (RSCL)	Cancer Rehabilitation Evaluation System*
	Fatigue	None reported		
		SF-36		
			EORTC QLQ-C30	Impact of Cancer (IOC)
	Pain	PedsQL		
		SF-36		
	Sexual Function	SF-36	Health Utilities Index Mark 3	UCLA-PCI*
	Urinary Incontinence	SF-36	SF-12	
	Weakness	hand grip strength	TUG	5 m max walk speed*
Neuropathy	ADL/IADL/ Extended IADLs	Community Health Activities Model Program For Seniors	Charlston comorbidity index	1-RM*
		Modified Total Neuropathy Score	TUG	6MWT*
	Balance	KPS	Other self-developed tools	Semmes Weinstein monofilaments*
		Semmes-Weinstein monofilament	Neurotip	Tip Therm Rod*
Pain	ADL/IADL/ Extended IADLs	Pain VAS	SF-36	Pain Disability Index*
Cardiorespiratory Fitness	Fatigue	Brief Cancer Impact Assessment (BCIA)	BSI-18	Perceived Stress Scale (PSS)
	Weakness	20 m gait speed	400 m walk	Hand grip strength
INTERVENTION FOR PHYSICAL FUNCTION				
Most Frequently Reported	Tool	(n)		
	SF-36	57		

Tools (> 5 studies)*		
EORTC QLQ-C30	40	
6MWT	33	
Anthropometric Measures	21	
Other self-developed tools	16	
Handgrip strength	14	
TUG	11	
Multidimensional Fatigue Inventory (MFI)	9	
Pediatric QOL Inventory (PedsQL)	9	
Range of Motion (ROM)	9	
Disabilities of Arm Shoulder & Hand (DASH)	9	
VO2 max	8	
Gait speed	8	
BFI	8	
Pain VAS	7	
Chair stand test	7	
Community Healthy Activities Model Program for Seniors (CHAMPS)	7	
Fatigue VAS	7	
Pittsburgh Sleep Quality Index (PSQI)	7	
Profile of Moods State (POMS)	6	
Godin Leisure-Time Exercise Questionnaire (GLTEQ)	6	
SF-12	6	
EORTC Modules	6	
MD Anderson Dysphagia Inventory	5	
Performance Status Scale for Head and Neck Cancer (PSS H&N)	5	

	Piper Fatigue Scale		5			
	State-Trait Anxiety Index (STAI)		5			
Type of cancer	Impairments (Primary and Secondary)		Measurement tools 1	Measurement tools 2	Measurement tools 3	
Brain	ADL/IADL/Extended IADLs	Balance	Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2)	VO2 peak		
	Fatigue		ECOG	Fatigue Severity Scale		
	Weakness		Functional Independence Measure (FIM)	Barthel Index	KPS	
Breast	ADL/IADL/Extended IADLs		DASH	Other self-developed tool	Other self-developed tools	
			EORTC QLQ-C30	ROM	Psychological adjustment scale	
			Handgrip strength	6MWT	Life Satisfaction Inventory	
			Other self-developed tools			
		Cardiorespiratory Fitness	SF-36	VO2 max		
		HRQOL	6MWT	SF-12	Arm volume	
			Fordyce Happiness Measure	Rosenberg Self-Esteem Scale (RSES)	Center for Epidemiology Studies Depression Scale (CES-D)	
			SF-12	Pain VAS	Sit-and-reach	
			SF-36	Level of physical activity		
		Pain	PROMIS			
		Weakness	DASH	12MWT	ROM	
		Balance	Weakness	Charlson Comorbidity Index	Short physical performance battery (SPPB)	5 times chair stand
		Cardiorespiratory Fitness	Bruce Protocol	Flowmate spirometer	Piper Fatigue Inventory	
			Global rating scale			
			Physical activity recall	6MWT	EORTC QLQ-C30	
	ADL/IADL/ Extended IADLs	Breast Cancer Prevention Trial Checklist	Symptom Distress Scale	CES-D		
	Cardiorespiratory Fitness	GLTEQ	Body Mass Index (BMI)			

		HRQOL	Minutes of moderate-vigorous Physical Activity			
			VO2 max	Dual-energy x-ray absorptiometry	Multidimensional Fatigue Inventory	
		Weakness	4MWT	Chair stand test	One-leg stance	
			6MWT	Fatigue Severity Scale	EORTC QLQ-C30	
			accelerometer	GLTEQ	Submaximal treadmill testing	
	Fatigue		Multidimensional Fatigue Inventory	PROMIS Fatigue		
			SF-36			
			ADL/IADL/ Extended IADLs	Cancer Fatigue Scale	PSQI	EORTC QLQ-C30
			HRQOL	5 time sit to stand	6MWT	Gait speed
				6MWT	Upper extremity ROM	
				Multidimensional Fatigue Inventory	SF-36	PSQI
			SF-36			
		Pain	SF-36			
	HRQOL		BPI	CES-D	State-Trait Anxiety Inventory	
				EORTC QLQ-C30		
					Constant Murley	DASH
				International Physical activity questionnaire	EORTC QLQ-C30	BFI
				Memorial Symptom Assessment Scale	SF-36	Sense of Coherence
				Post Traumatic Growth Inventory	Ten Rules for Highly Effective Health Behavior	EORTC QLQ-C30
				SF-12		
				SF-36		
					Body Image and Relationships Scale (BIRS)	1-RM
			ADL/IADL/ Extended IADLs	Concerns about Recurrence Scale	State-Trait Anxiety Inventory	CES-D
				EORTC QLQ-C30		
			PHQ-9	Minnesota Physical Activity Questionnaire	BFI	

			SF-36	EORTC QLQ-C30	EORTC Modules		
				WOMAC	strength testing		
		Cardiorespiratory Fitness	EORTC QLQ-C30	SF-36			
		Fatigue	Physical Activity Readiness Questionnaire	GLTEQ	1-RM		
			SF-36	Coopersmith Self-Esteem Inventory (SEI)	Fatigue Symptom Inventory		
	Lymphedema		Lymphedema symptom intensity and distress survey - arm (LSIDS-A)	Functional assessment screening questionnaire (FASQ)	BMI		
		HRQOL	SF-36				
	Pain	Weakness	Mini Mental State Exam	FIM			
	Sexual Function	HRQOL	Pain VAS	Sexual Activity Questionnaire	Female Sexual Function Index (FSFI)		
	Weakness	Balance	Biodex System 3 Pro Velocity Spectrum Evaluation	Timed backward tandem walk	Other self-developed tools		
			Cardiorespiratory Fitness	DASH			
			Strength	6MWT	VO2 max		
			VO2 max	Timed sit-to-stand test	Sit-and-reach		
Colon	ADL/IADL/Extended IADLs		6MWT				
	Balance	Weakness	TUG	Modified Clinical Test of Sensory Interaction on Balance (mCTSIB)	Dynamic Gait Index		
	Cardiorespiratory Fitness	ADL/IADL/ Extended IADLs		Tecumseh step test			
		Fatigue		EORTC QLQ-C30	Multidimensional fatigue inventory	National Comprehensive Cancer Network (NCCN) distress thermometer	
				Other self-developed tools			
				PA level	Fatigue VAS	POMS	
			HRQOL	Senior's fitness test	SF-36	CES-D	
		Sit to stand					
		Weakness	SF-36	Fatigue Symptom Inventory			
		HRQOL		EORTC QLQ-C30	6MWT	VO2 max	

			SF-36			
		ADL/IADL/ Extended IADLs	Other self-developed tools			
		Fatigue	SF-36			
	Sexual Function		Index of Sexual Satisfaction (sexual distress)	Female Sexual Function Index (FSFI)	International Index of Erectile Functioning	
Gynecological	Cardiorespiratory Fitness	ADL/IADL/ Extended IADLs	6MWT			
	HRQOL	ADL/IADL/ Extended IADLs	National Health and Nutrition Survey			
		Cardiorespiratory Fitness	Brief Symptom Inventory-18	SF-36	Accelerometer	
		Neuropathy	SF-36			
	Lymphedema	ADL/IADL/ Extended IADLs	water displacement	circumferential measurements	BMI	
Head and Neck	ADL/IADL/Extended IADLs		SPADI	Neck Dissection Impairment Index		
	Balance	ADL/IADL/ Extended IADLs	One leg stance	6MWT		
	Cardiorespiratory Fitness	Weakness	Anthropometric measures	Hand grip strength	30 second sit to stand	
	HRQOL			EORTC QLQ-C30	EORTC Modules	
				SF-36	Neck Dissection Impairment Index	SF-12
	Joint Mobility			M.D. Anderson Dysphagia Inventory (MDADI)	Performance Status Scale for Head and Neck Cancer	Functional Oral Intake Scale
				ROM	SF-36	
	Speech and swallowing			Modified barium swallow test	MD Anderson Dysphagia inventory	Performance Status Scale for HNC patients
				Other self-developed tools		
				Penetration aspiration scale	Oropharyngeal swallow efficiency scale	Hyoid excursion
			HRQOL	EORTC QLQ-C30	EORTC Modules	Danish Head & neck Cancer Group dysphagia score
			Videofluoroscopy	Mouth Opening ROM	Functional oral intake scale	
	Weakness			AROM	SPADI	Neck Dissection Impairment Index

Hematological	ADL/IADL/Extended IADLs	Balance	BOT-2	Tandem gait	Hopping on one leg
		Weakness	6MWT	muscle strength	ankle ROM
	Cardiorespiratory Fitness	Weakness	PedsQOL general	PedsQOL cancer	
	HRQOL	ADL/IADL/ Extended IADLs	SF-36		
		Fatigue	Pain VAS	KPS	EORTC QLQ-C30
	Weakness	ADL/IADL/ Extended IADLs	TUG	Timed up and down stairs	Checklist Individual Strength
Lung	Fatigue	HRQOL	Fatigue VAS	EORTC QLQ-C30	Distress thermometer
	HRQOL		SF-36		
		Cardiorespiratory Fitness	SF-36	6MWT	
Prostate	ADL/IADL/Extended IADLs	Weakness	6MWT	1-RM	30 second sit to stand
			EORTC QLQ-C30	Late life function and disability index (LLFDI)	Schwartz Cancer Fatigue Scale
	Body weight	Fatigue	Anthropometric Measures	Fatigue Severity Scale	6MWT
	Cardiorespiratory Fitness	Fatigue	BMI	Senior fitness test battery	Pedometer
	HRQOL	ADL/IADL/ Extended IADLs	EORTC QLQ-C30	Sit to stand	2MWT
			Expanded Prostate Cancer Index Composite (EPIC)	Risk for Distress Scale	
			SF-36	Chair rise test	1-RM
	Urinary Incontinence	HRQOL	University of California-Los Angeles Prostate Cancer Index	EPIC	
				Incontinence VAS	SF-3 PCS
	Weakness	ADL/IADL/Extended IADLs	1-repetition maximum chest press and leg press	Short physical performance battery (SPPB)	SF-36
Urinary Incontinence		Pelvic floor strength measures			
Sarcoma	ADL/IADL/Extended IADLs		Musculoskeletal Tumor Society Scale (MSTS)		
Various	ADL/IADL/Extended IADLs		KPS	ECOG	Comprehensive geriatric assessment
			FIM		

		PedsQL		
		SF-36	EORTC QLQ-C30	
			Late Life Function and Disability Instrument (LLFDI)	EORTC QLQ-C30
	Fatigue	BOT-2	GLTEQ	TUG
		Short questionnaire to assess health-enhancing physical activity (SQUASH)	Accelerometer	
		Sickness Impact Profile	VO2 max	Checklist Individual Strength (CIS)
	HRQOL	SF-36	LLFDI	
	Joint Mobility	EORTC QLQ-C30	6MWT	SF-36
	Neuropathy	Berg balance scale (BBS)	Static-dynamic posturography	mCTSIB
	Balance	Fullerton Advanced Balance Scale	Balance Efficacy Scale	Other self-developed tool
		5 time sit to stand	Single heel raises	
	Weakness	Charlson Comorbidity Index	Community health activity model program for seniors (CHAMPS)	1-RM
	Cardiorespiratory Fitness	6MWT		
			Oxford Happiness Questionnaire	RSES
		EORTC QLQ-C30		
	ADL/IADL/ Extended IADLs	SF-36	CHAMPS	BMI
	Fatigue	Duke Activity Status	6MWT	
		Handgrip strength	Chair stand test	Multidimensional Fatigue Inventory
		Patient Health Questionnaire-9	Schwartz Cancer Fatigue Scale	Dartmouth Cooperative Functional Assessment Charts
	HRQOL	Accelerometer	Handgrip strength	Sit-up/push-ups
		EORTC QLQ-C30	6MWT	SF-36
		Peds QL	Physical Activity Self-Efficacy	

		SF-36		
	Weakness	BMI	Anthropometric measures	SF-12
Fatigue		Fatigue VAS	Ecological momentary assessment	Rhoten Fatigue Scale
		Oncology Nursing Society (ONS) Fatigue Scale		
	ADL/IADL/ Extended IADLs	CIS	Sickness Impact Profile	Sleep Quality Scale
		Fatigue Symptom Inventory		
	Balance	ECOG	Tinetti Mobility Test	TUG
	Cardiorespiratory Fitness	BFI	30-second chair stand	Modified Bruce Protocol
		GLTEQ	International Physical Activity Questionnaire	7-day Physical Activity recall
	HRQOL	Fatigue Assessment Questionnaire	EORTC QLQ-C30	General Self-Efficacy Scale
		EORTC QLQ-C30	12MWT	
		SF-36	Other self-developed tools	PSQI
HRQOL	Cancer Rehabilitation Evaluation System	EORTC QLQ-C30	Quality of Life Index for Cancer Patients	
		EORTC QLQ-C30	EORTC Modules	
			PSQI	Physical Activity Scale for Elders
		Peds QL		
	ADL/IADL/ Extended IADLs	Edmonton Symptom Assessment Scale	6MWT	Timed Sit to Stand test
		TUG	SF-36	
		SF-36		
			EORTC QLQ-C30	EORTC Modules
		LLFDI	Community Health Activities Model Program for Seniors questionnaire	
	Cardiorespiratory Fitness	EORTC QLQ-C30	Astrand 6-minute Cycle Test	Hand grip strength
		GLTEQ	6MWT	SF-36
		SF-36	other self-developed tool	
	Fatigue	EORTC QLQ-C30	EORTC Modules	Piper Fatigue Inventory

			SF-36		
	Joint Mobility	ADL/IADL/ Extended IADLs	DASH	BPI	Pain VAS
	Neuropathy	Pain	SF-36	MDASI	BPI
	Sexual Function		PCI/EPIC		
	Weakness	Cardiorespiratory Fitness	Anthropometric Measures	Handgrip strength	6MWT
		Fatigue	SF-36	BIRS	VO2 Peak

ASSESSMENT OF PHYSICAL FUNCTION

Most Frequently Reported Tools (> 5 studies)*	Tool	n	Tool	n
		SF-36	186	Pittsburgh Sleep Quality Index (PSQI)
	EORTC QLQ-C30	139	Multidimensional Fatigue Inventory	7
	Other self-developed tools	77	Quality of Life Cancer Survivors (QOL-CS)	7
	EORTC Modules	69	Impact of Cancer (IOC)	7
	6MWT	39	European Prospective Investigation into Cancer Physical Activity Questionnaire (EPIC)	7
	DASH	31	Fatigue VAS	6
	SF-12	28	University of Washington Quality of Life questionnaire (UW-QOL)	6
	PROMIS	21	Short Physical Performance Battery (SPPB)	6
	Timed Up and Go (TUG)	19	Brief Fatigue Inventory	6
	KPS	18	Sexual Functioning Questionnaire (SFQ)	6
	Brief Symptom Inventory	16		
	Handgrip strength	16		
	Pediatric Quality of Life Inventory (PedsQL)	13		
	Gait speed	12		

	ROM	12		Late Life Function Disability Index (LL-FI)	5
	Toronto extremity salvage score (TESS)	12		Lawton–Brody Index of instrumental activities of daily living	5
	ECOG	11		Shoulder Pain and Disability Index	5
	Musculoskeletal Tumor Society Scoring System (MSTS)	11		CTCAE	5
	Expanded Prostate Cancer Index Composite (EPIC)	11		1-RM	5
	Pain VAS	11		chair stand test	5
	BMI	10		Charlson Comorbidity Index	5
	sit & reach	10		Functional Independence Measure (FIM)	5
	Brief Pain Inventory	8		Impact of Event Scale (IES)	5
	Cancer Rehabilitation Evaluation System (CARES)	8		Supportive Care Needs Survey (SCNS-SF34)	5
	UCLA Prostate Cancer Index (PCI)	8			
	EuroQoL EQ-5D-5L	8			
	Performance Status Scale for Head and Neck (PSS-HN)	8			
	Quality of Life Adult Cancer Survivors (QLACS)	8			
Type of Cancer	Impairments (Primary and Secondary)		Measurement tools 1	Measurement tools 2	Measurement tools 3
Bladder	HRQOL	Urinary Incontinence	EORTC QLQ C-30	EORTC Modules	Bladder Cancer Index
	Urinary Incontinence	Fecal Incontinence	Bladder cancer index		
		Sexual Function	Semi structured interview		

	Weakness	Pain	Leg power on dominant side using Nottingham Leg Extensor Power Rig®		
Bone	ADL/IADL/Extended IADLs		Musculoskeletal Tumor Society Rating Scale (MSTS)		
Brain	ADL/IADL/Extended IADLs		Bruininks-Osteretsky Test of Motor Performance (BOT-2)		
			Functional Independence Measure (FIM)	Perceived Impact Problem Profile (PIPP)	Cancer Rehabilitation Evaluation System Short Form
			Health Utilities Index™ Mark2/3 (HUI2/3)		
			KPS		
			Other self-developed tools		
			Romberg Test	Childhood Orientation and Amnesia Test	
		HRQOL	ECOG	RUG-ADL (Resource Utilization Groups Activities of Daily Living)	
			HUNT-3 Based Measures	BMI	
		Other	BRIGANCE Diagnostic Comprehensive Inventory of Basic Skills–Revised		
	Balance	Other	Zurich Neuromotor Assessment	Visuomotor integration (VMI)	
	Fatigue	Neuropathy	Other self-developed tools		
		HRQOL		Distress thermometer	
				EORTC QLQ C-30	EORTC Modules

		Pediatric Quality of Life (PedsQL)			
		SF-36			
			EORTC Modules		
		ADL/IADL/Extended IADLs	EORTC QLQ C-30		
			European Quality of Life-5 Dimensions (EQ-5D)	EORTC-QLQ-30	EORTC Modules
			Minneapolis-Manchester Quality of life (MMQL) questionnaire		
		Cardiorespiratory Fitness	Godin Leisure Time Exercise Questionnaire (GLTEQ)	12-lead ECG	Expired gas analysis
			VO2 max	SF-36	Satisfaction with Life Scale
		Fatigue	EORTC QLQ C-30	BN20	KPS
		Pain	PROMIS	Day Rehabilitation Outcome Scale	
Breast	ADL/IADL/Extended IADLs	6MWT			
		Canadian Occupational Performance Measure (COPM)	Model of Human Occupation (MOHO)	Person-Environment-Occupation-Performance model	
		DASH			
			Penn Shoulder Score		Shoulder Disability Questionnaire-D
			SPADI		Shoulder Rating Questionnaire
		ECOG	Katz Index of ADLs		

		Geriatric Assessment	Adult Comorbidity Evaluation Index (ACE-27)	Charlson Comorbidity Index
		Inventory of Functional Status for Cancer (IFSA-Ca)	Multidimensional Scale of Perceived Social Support (MSPSS)	
		Medical Research Council scale (muscle power)	Pain VAS	Limb girth
		Other self-developed tools		
		Personal Role Domain scale	Late Life Function and Disability Index	Other self-developed tool
		ROM	Strength	other self-developed tools
		SF-12	Other self-developed tools	
		SF-36		
			6MWT	12MWT
		Short Physical Performance Battery SPPB	Standing from a chair test	Gait speed
		Work Limitation Questionnaire (WLQ)	Return to work VAS	
	Fatigue	Late-Life Function and Disability Instrument	Satisfaction with Life Scale (SWLS)	
	HRQOL	12MWT		
		DASH	SF-36	1-RM
		EORTC QLQ C-30		
		Fordyce Happiness Measure (FM)	Rosenberg Self-Esteem Scale	Cohen's 10-item Perceived Stress S

		Katz's activities of daily living index	Lawton–Brody Index of instrumental activities of daily living	ECOG
		Maximal aerobic fitness	6MWT	12MWT
		Pain VAS	Walking diary	Western Ontario and McMaster Uni Osteoarthritis Index (WOMAC)
		QuickDASH		
		SF-36	Late Life Function and Disability Index	
	Joint Mobility	DASH	ROM	
		SPADI	ROM	
	Lymphedema	DASH		
	Pain	Breast Cancer Treatment Outcome Scale	EORTC QLQ-C30	
	Weakness	TUG	1RM	Back scratch test
	Balance	Tinetti-POMA	Gait speed	TUG
	Cardiorespiratory Fitness	KPS		
	ADL/IADL/Extended IADLs	EORTC QLQ C-30		
		Functional Impairment Test – Hand and Neck/Shoulder/ Arm (FITHaNSA)	International Physical Activity Questionnaire (IPAQ)	DASH
	Fatigue	ECOG	Physical Activity Readiness Questionnaire (PAR-Q)	Physical Activity Readiness Medical Examination (PARmed-X)

	HRQOL	Scottish Physical Activity Questionnaire-2 (SPAQ)	12MWT	BMI	
		SF-36			
		Other	SF-36	Personal Habits Questionnaire	
		Pain	Western Ontario and McMaster Universities Osteoarthritis		
		Weakness	Naughton protocol estimated fitness submax treadmill test		
	Fatigue		SF-36		
		ADL/IADL/Extended IADLs	SF-36		
		HRQOL	Piper Fatigue Scale	SF-36	Cancer Inventory of Problem Situations
		Other	Cancer Survivor Profile		
		Pain	SF-36	7-Day Physical Activity Recall Questionnaire	
	HRQOL		EORTC QLQ C-30		
				EORTC Modules	
					SF-36
				PROMIS	SF-36
				Questionnaire on Stress in Cancer Patients	EORTC Modules
			SF-36		
		Long Term Quality of Life–Breast Cancer (LTQOL-BC) Scale			
	Other self-developed tools				

		PAIS-SR (psychosocial adjustment illness scale-self report)	SF-36	
		SF-8		
		SF-12		
		SF-36		
			Impact of cancer (IOC) scale	
			Other self-developed tools	
			Pittsburgh Sleep Quality Index	
			Subjective Well-being	
	ADL/IADL/Extended IADLs	chair stand test		
		DASH		
			Lymphoedema Functioning	Disability and Health Questionnaire
		EORTC QLQ C-30	EORTC Modules	CTCAE
		Fatigue VAS	SF-12	Social Provisions Scale for Exercise
		Katz's activities of daily living index	Lawton-Brody Index of instrumental activities of daily living	EORTC QLQ-C30
		Other self-developed tools		
		PHQ-9	EORTC QLQ-C30	
		SF-36		
			2 min step test	8ft get up & go
			PF-10	Pittsburgh Sleep Quality Index
			VR-12	
			WHOQOL-100	

				Women's Health Initiative	BMI
			WHO-QOL		
		Fatigue	EORTC QLQ C-30	EORTC Modules	
				Impact of Event Scale (IES)	Fatigue Symptom Inventory (FSI)
				SF-36	
			SF-36	Harvard Alumni Health Study Physical Activity Questionnaire (HPAQ)	QuickDASH
		Other	SF-36	Ladder of Life	Perceived Efficacy in Patient-Physician Interactions
				Pittsburgh Sleep Quality Index (PSQI)	Symptom experience report (SER)
		Pain	EORTC QLQ C-30	EORTC Modules	
			Other self-developed tools		
		Sexual Function	National Surgical Adjuvant Breast and Bowel Project Breast Cancer Prevention Trial (BCPT) Hormonal Symptom Checklist	Modifiable Activity Questionnaire	Cancer Rehabilitation Evaluation System
		Weakness	EORTC QLQ C-30	EORTC Modules	Handgrip strength
	Joint Mobility		DASH	Penn Shoulder Scale	ROM
		ADL/IADL/Extended IADLs	Other self-developed tools		
			QuickDASH		
		Lymphedema	AROM	Pain VAS	Circumferential arm measures
		Pain	BreastQ	DASH	Upper Extremity Functional Index (UEFI)
			DASH	ROM	Pain VAS

	Lymphedema	Psychosocial Adjustment to Illness Scale (PAIS)	SF-36		
		ADL/IADL/Extended IADLs	DASH		
			Kwan's Arm Problem Scale	EORTC Module	SF-36
			Penn Shoulder Score	Lymph ICF	Volumeter
		Fatigue	ISL staging criteria for lymphedema		
		HRQOL	SF-36	Armer self-reported lymphedema symptom scale	
	Pain	DASH	McGill Pain Questionnaire- Short form	Social Impact of Arm Morbidity (SIA) Questionnaire	
		Short Form McGill Pain Questionnaire	DASH	Social Impact of Arm Morbidity (SIA) Questionnaire	
	Neuropathy	ADL/IADL/Extended IADLs	Functional reach	Sit & reach	Berg Balance Test
		Balance	Functional reach	Sit & reach	Patient-specific functional scale (PS)
		Pain	Monofilament set		
	Pain	ADL/IADL/Extended IADLs	Arthritis Self-Efficacy Scale (ASE)	Pain VAS	
			Brief Pain Inventory		
			KPS	Self-Administered Comorbidity Questionnaire	NPRS
		HRQOL	Pain VAS	SF-36	
		Joint Mobility	DASH	SF-36	
Weakness		DASH	Norman Lymphedema Questionnaire	Lymphedema Breast Cancer Quest	

	Sexual Function		Menopause Specific Quality of Life Questionnaire		
		ADL/IADL/Extended IADLs	None recommended		
		Other	Female Sexual Function Index (FSFI)	Other self-developed tools	
		Urinary Incontinence	SF-36		
	Urinary Incontinence	Sexual Function	PROMIS		
	Weakness	ADL/IADL/Extended IADLs	6MWT	ROM	Handgrip strength
			AROM	DASH	Penn Shoulder Score
			squat test	DASH	6MWT
		Cardiorespiratory Fitness	None recommended		
			VO2 max	Upper extremity strength	Sit and reach
HRQOL		Constant-Murly	Rowe score	DASH	
Joint Mobility		Selective Functional Movement Assessment (SFMA)			
	Upper Body Strength and Endurance (UBSE)	DASH			
Colon	ADL/IADL/Extended IADLs	European Prospective Investigation into Cancer Physical Activity Questionnaire	EORTC QLQ-C30		
		Other self-developed tools			
	HRQOL	EORTC QLQ C-30	SF-36		
	Joint Mobility	6MWT	30sec chair stands	8ft get up & go	
	Cardiorespiratory Fitness	ADL/IADL/Extended IADLs	6MWT		

	Fatigue	Pain	EORTC QLQ C-30	Other self-developed tools			
	HRQOL		EORTC QLQ C-30	EORTC Modules			
			European Prospective Investigation into Cancer Physical Activity Questionnaire	EORTC QLQ-C30			
			Modified City of Hope Quality of Life/Ostomy (mCOH-QOL-O)				
			SF-36				
		ADL/IADL/Extended IADLs		EORTC QLQ C-30			
					European Prospective Investigation into Cancer (EPIC) physical activity questionnaire		
					World Health Organization Disability Assessment		
					European Prospective Investigation into Cancer Physical Activity Questionnaire (EPIC)	EORTC QLQ-C30	
					SF-12		
						Other self-developed tools	
			Short questionnaire to assess health-enhancing physical activity (SQUASH)				
		Fatigue	EORTC QLQ C-30				
			Fatigue Assessment Scale (FAS)	EORTC QLQ-C30	Self-Administered Comorbidity Questionnaire (SCQ)		
			SF-36	Community Healthy Activities Model			

				Fatigue Assessment Scale (FAS)	BMI
	Neuropathy	ADL/IADL/Extended IADLs	EORTC QLQ C-30	EORTC Modules	
		HRQOL	Chemotherapy-Induced Peripheral Neuropathy Assessment Tool (CIPNAT)	SF-36	
	Pain		SF-12	Brief Pain Inventory (BPI)	
		HRQOL	EuroQOL	Other self-developed tools	
	Sexual Function	HRQOL	EORTC QLQ C-30		
					EORTC Modules
Germ Cell	HRQOL	Neuropathy	EORTC QLQ C-30		
Gynecological	ADL/IADL/Extended IADLs		6MWT		
			National Health Interview Survey		
			National Surgery Quality Improvement Database questionnaire		
			Other self-developed tools		
		HRQOL	M.D. Anderson Symptom Inventory (MDASI) Interference Scale	Symptom Representation Questionnaire (SRQ)	
		Lymphedema	SF-12		
		Pain	Paffenbarger Physical Activity Questionnaire	Brief Pain Inventory (BPI)	Fatigue Symptom Inventory (FSI)
		Sexual Function	Supportive Care Needs Survey– gynecologic version (SCNS-gyne)	Sexual Function–Vaginal Changes Questionnaire (SVQ)	
		Weakness	6MWT	30sec chair stands	30sec arm curls

	Cardiorespiratory Fitness		modified Balke protocol	Vo2 peak	
			Other self-developed tools		
	HRQOL		EORTC QLQ C-30	EORTC Modules	
				Hornheider Questionnaire (HFK-B)	
			SF-36		
	ADL/IADL/Extended IADLs		EORTC QLQ C-30	EORTC Modules	McGill QOL
			SF-36		SF-36
	Cardiorespiratory Fitness		EORTC QLQ C-30	KPS	Spirometer
	Fatigue		SF-36		
				EORTC Modules	SCQ
	Pain		EORTC QLQ C-30		
	Sexual Function		EORTC QLQ C-30	EORTC Modules	SF-36
			Female Sexual Function Index (FSFI)	Menopausal Rating Scale (MRS)	
			SF-36		
				Quality of Life Adult Cancer Survivors (QLACS)	
	Urinary Incontinence		EORTC QLQ C-30		
			SF-36	Other self-developed tools	
	Lymphedema	Other	Limb Volume perometry	Gynecologic Cancer Lymphedema Questionnaire	
	Pain	Sexual Function	Other Self-developed tools		

	Sexual Function	Other	EORTC QLQ C-30	SF-36	Female Sexual Function Inventory (FSFI)
	Urinary Incontinence	Fecal Incontinence	Sandvik Incontinence Severity Index	Wexner Fecal Incontinence Scale	Epidemiology of Prolapse and Incontinence Questionnaire
			Urogenital Distress Inventory (UDI)		
	Weakness		Pelvic floor strength		
Head and Neck	ADL/IADL/Extended IADLs		6MWT		
			KPS		
			Neck Disability Index (NDI)	Shoulder Pain and Disability Index	UW-QOL
		Other	KPS	ECOG	Penn Shoulder Score
	Communication	ADL/IADL/Extended IADLs	Communication Participation Item Bank (CPIB)	PROMIS	Neuro-QoL
	HRQOL		EORTC QLQ C-30	EORTC Modules	
			UW-QOL		
		Fatigue	SF-12		
		Fecal Incontinence	EORTC QLQ C-30	EORTC Modules	
		Joint Mobility	UWQOL	Performance Status Scale for Head and Neck (PSS-HN)	
		Other- pls comment	WHO Quality of Life–Bref Scale	Australian Therapy Outcome Measures (AusTOMs)	General Self-Efficacy Scale (GSES)
	Lymphedema	HRQOL	None recommended		
	Speech swallowing		GRBAS rating system (severity rating of voice quality - grade/overall severity of dysphonia)	V-RQOL	VHI

			MD Anderson Dysphagia Inventory (MDADI)	Performance Status Scale-Head and Neck (PSS-HN)	
Hematological	ADL/IADL/Extended IADLs		6MWT	TUG	
			Dizziness Handicap Inventory	Brief Fatigue Inventory	Migraine Disability Assessment Scale
			Fundamental Movement Skills Test Battery		
			Knee Society Score (KSS)		
			Musculoskeletal Tumor Society Rating Scale (MSTS)		
			Other self-developed tools		
			Pediatric Quality of Life (PedsQL)	Child Health Questionnaire	Child Health Ratings Inventories
			Pepper Assessment Tool for Disability	Short Physical Performance Battery (SPPB)	Grip strength
			PROMIS		
			SF-36	Other self-developed tools	
			UQAC-UQAM test battery		
		Weakness	6MWT	TUG	Handgrip strength
	Balance	ADL/IADL/Extended IADLs	modified Total Neuropathy Score	SOT	TUG
Cardiorespiratory Fitness	Weakness	Handgrip strength			
Fatigue		SF-36	Fatigue Questionnaire		
	ADL/IADL/Extended IADLs	SF-36	EORTC QLQ-C30		
	Pain	AQoL-6D	Other self-developed tools		

			Physical Distress by Symptom Distress Scale (SDS)		
			PROMIS		
	HRQOL				
			Cancer Rehabilitation and Evaluation System (CARES)	SF-36	Distress thermometer
			EORTC QLQ C-30		
			Family Environment Scale	Brief Symptom Inventory	Parent Protection Scale
			None recommended		
			Pediatric Quality of Life (PedsQL)		
			SF-12	EORTC Modules	
			SF-36		
				Charlson comorbidity index	
				ECOG	
				EORTC QLQ-C30	
				General Health Questionnaire (GHQ-12)	
				Human Activities Profile (HAP)	
				Other self-developed tools	
				Other self-developed tools	

				Quality of Life Adult Cancer Survivors (QLACS)	
	ADL/IADL/Extended IADLs	Brief Symptom Inventory	CARES		EORTC QLQ-C30
		Child Health Questionnaire (CHQ-PF50)			
		EORTC QLQ C-30			
		Sickness Impact Profile			Other self-developed tools
		SF-6D			
		SF-36			
	Fatigue	EORTC QLQ C-30	Lawton–Brody Index of instrumental activities of daily living		2MWT
		Schedule for the Evaluation of Individual Quality of Life-Direct Weighting (SEIQoL-DW)	SF-36		
		SF-36			
	Pain	SF-12	EORTC QLQ-C30		EORTC Modules
Joint Mobility	Pain	SF-36	Fatigue Symptom Inventory		
Pain	ADL/IADL/Extended IADLs	FMA			
		HUI Mark 3 (HUI3)			
	Weakness	Neck Disability Index (NDI)	Checklist Individual Strength-20 (CIS-20)		Other self-developed tools
Sexual Function	Fatigue	Quality of Life Questionnaire for survivors (QLQ-S)	EORTC QLQ-C30		SX scale
	HRQOL	BSFI			
		Sexual Activity Questionnaire	Prostate Cancer Outcomes Study		Sexual Functioning Questionnaire

	Weakness	ADL/IADL/Extended IADLs	Grip strength			
		Balance	Other self-developed tools			
Lung	ADL/IADL/Extended IADLs		SF-36	Other self-developed tools		
	Cardiorespiratory Fitness		CPET	6MWT	Stair Climbing Test (SCT)	
		Fatigue		6MWT	EORTC-QLQ-C30	EORTC Modules
	Fatigue	HRQOL	Brief Fatigue Inventory	EORTC QLQ-C30		
	HRQOL			EORTC QLQ C-30	EORTC Modules	
				SF-8	Lung Cancer Symptoms Scale (LCSS)	
				SF-36		
			ADL/IADL/Extended IADLs	EORTC QLQ C-30		
				SF-36		
			Fatigue	Brief Fatigue Inventory	KPS	Godin Leisure-Time Exercise Quest
			Other	EORTC QLQ C-30	Other self-developed tools	
		Pain	Edmonton Symptom Scale	Other self-developed tools		
	Joint Mobility	Pain	Northwick Park Neck Pain Questionnaire (NPNPQ)	Neck Pain and Disability Scale (NPDS)	Pain VAS	
Weakness	ADL/IADL/Extended IADLs	1RM	Respiratory pressure meter	TUG		
Melanoma	HRQOL		SF-36	Impact of cancer (IOC) scale		
		ADL/IADL/Extended IADLs	SF-36	Other self-developed tools		
		Fatigue	Hornheide Questionnaire 9 items short form (HQ-S)	EORTC QLQ-C30	EORTC modules	

		Lymphedema	EORTC QLQ C-30	EORTC Modules		
Neuroendocrine	HRQOL		SF-36	Impact Event Scale (IES)	General Self-Efficacy Scale (GSES)	
other GI	ADL/IADL/Extended IADLs		Other self-developed tools			
	Fatigue	Pain	Other self-developed tools			
	Fecal Incontinence	HRQOL	EORTC QLQ C-30			
		Sexual Function	EORTC QLQ C-30			
	HRQOL		EORTC QLQ C-30			
			EORTC Modules			Brief Illness Perception Questionnaire
			SF-36	KPS		
	ADL/IADL/Extended IADLs	Accelerometer		6MWT		
		ECOG		EORTC QLQ-C30		
		EORTC QLQ C-30		EORTC Modules		
		Female Sexual Functioning Index (FSFI)		EORTC QLQ-C30		
	Fatigue			EORTC QLQ C-30		
				EORTC Modules		
	Fecal Incontinence	Modified City of Hope Quality of Life Ostomy (mCOH-QOL-O)		SF-12		Duke-UNC Functional Social Support Questionnaire (FSSQ)
	Other			EORTC QLQ C-30		
Pain			EORTC QLQ C-30			
Sexual Function		Other self-developed tools				

Prostate	ADL/IADL/Extended IADLs		TUG	Repeated chair stands	Handgrip strength	
		Fatigue	PROMIS			
		Weakness	400m walk	6MWT	TUG	
	HRQOL		EORTC Modules	EORTC Modules	EQ-5D	
				UCLA Prostate Cancer Index (PCI)	PCQoL	
			EORTC QLQ C-30			
				EORTC Modules		
			European Prospective Investigation into Cancer Physical Activity Questionnaire	Brief Symptom Inventory		
			SF-12	Expanded Prostate Cancer Index Composite (EPIC)	Appraisal of Illness Scale (AIS)	
					Satisfaction with Life Scale	
			SF-36			
		ADL/IADL/Extended IADLs		EORTC QLQ C-30	Walking distance	Sit and reach
				Godin Leisure-Time Exercise Questionnaire	SF-36	400m walk
				SF-12		
				SF-36	UCLA Prostate Cancer Index (PCI)	
			Fatigue	European Prospective Investigation into Cancer Physical Activity Questionnaire	SF-12	Other self-developed tools
			Pain	UCLA Prostate Cancer Index (PCI)		
	Sexual Function	Expanded Prostate Cancer Index Composite (EPIC)				

			Quality of Life Questionnaire for survivors (QLQ-S)	SF-36	EPIC
		Urinary Incontinence	EORTC QLQ C-30	EQ-5D-5L	
			Expanded Prostate Cancer Index Composite (EPIC)	Supportive Care Needs Survey (SCNS-SF34)	Modified Self-efficacy Scale
			Patient oriented prostate utility score (PORPUS)	International Prostate Symptom Score	International Index of Erectile Function
			Patient-Oriented Prostate Utility Scale (PORPUS)	5-item International Index of Erectile Function (IIEF)	International Prostate Symptom Score
			SF-12	Expanded Prostate Cancer Index Composite (EPIC)	
			UCLA Prostate Cancer Index (PCI)	Expanded Prostate Cancer Index Composite (EPIC)	
				Other self-developed tools	
	Sexual Function	Urinary Incontinence	Expanded Prostate Cancer Index Composite (EPIC)		
	Urinary Incontinence		UCLA Prostate Cancer Index (PCI)		
		Fecal Incontinence	EORTC QLQ C-30	EQ-5D-5L	
			UCLA Prostate Cancer Index (PCI)	SF-36	
	Weakness	ADL/IADL/Extended IADLs	Bench and leg press tests	Seniors' Fitness Test	SF-36
Sarcoma	ADL/IADL/Extended IADLs		Assessment of Motor and Process Skills (AMPS)		
			MSTS		
			Musculoskeletal Tumor Society Rating Scale (MSTS)		

		Toronto Extremity Salvage Scale (TESS)			
			Reintegration into Normal Living Index (RNL)		
		UCLA sports activity score			
	Cardiorespiratory Fitness	6MWT	Brief Symptom Inventory	Physical Assessment Battery	
	HRQOL	6MWT	Sit & reach	Balance	
		Musculoskeletal Tumor Society Rating Scale (MSTS)	Toronto Extremity Salvage Score (TESS)	SF-36	
		Other self-developed tools			
	Pain	Musculoskeletal Tumor Society Rating Scale (MSTS)			
		Other self-developed tools			
	Sexual Function	Toronto Extremity Salvage Scale (TESS)			
	HRQOL	EORTC QLQ C-30	SF-36	Musculoskeletal Tumor Society Rating Scale (MSTS)	
		Musculoskeletal Tumor Society Rating Scale (MSTS)	Toronto Extremity Salvage Scale (TESS)	SF-36	
		Toronto Extremity Salvage Scale (TESS)			
		ADL/IADL/Extended IADLs	SF-36	Toronto Extremity Salvage Scale (TESS)	Timed sit to stand
			Toronto Extremity Salvage Scale (TESS)	EORTC QLQ-C30	SF-36
				SF-36	Brief Symptom Inventory (BSI)
Testicular	HRQOL	Cancer Assessment for Young Adults (CAYA)			
		SF-36			

		ADL/IADL/Extended IADLs	SF-36		
		Fatigue	SF-36		
Various	ADL/IADL/Extended IADLs		6MWT		
			Brief Symptom Inventory	Global Rating Severity Scale	CCSS Neurocognitive scale
			Canadian Occupational Performance Measure (COPM)	Adolescent Activity Card Sort (AACS)	
			DASH		
			Duke Activity Status Index	BMI	Physical Performance Test (PPT)
			EORTC QLQ C-30	SF-12	SF-36
			Functional Independence Measure (FIM)		
			Grooved pedboard	Other self-developed tools	
			Nagi's Performance Limitations Index		
			National Disability Database query		
			Occupational Self-Assessment (Version 2.2)		
			Other self-developed tools		
				Gait speed	
			Patient neurotoxicity questionnaire		
			PROMIS	Other self-developed tools	
			Return to work statistics		
	Rosow-Breslau questionnaire				

		SF-36	Brief Symptom Inventory	CCSS Neurocognitive scale
			Other self-developed tools	
		SF-37	OARS	KPS
		Short Physical Performance Battery SPPB		
		Useful Field of View (UFOV®)	WAIS Digit Symbol Substitution	Timed Instrumental Activities of Daily Living
		Vulnerable Elders Survey (VES)		
			Comprehensive Geriatric Assessment	Barthel Index
		Work Related Activity Limitation Questions		
	Cardiorespiratory Fitness	EORTC QLQ C-30	Other self-developed tools	
		Handgrip strength	SF-36	
		Other self-developed tools		
		SF-36		
	Fatigue	Geriatric assessment	Mini Mental Status Exam (MMSE)	Katz Index of ADLs
		Short questionnaire to assess health-enhancing physical activity (SQUASH)	Accelerometer	
	HRQOL	AM-PAC	PROMIS	ECOG
Childhood Cancer Survivor Study Questionnaire				
DASH				
EORTC QLQ C-30		SF-36		
KPS		ECOG	SF-36	

					VO2max
			PROMIS	SF-36	
			SF-36	Physical performance test (PPT)	6MWT
				Toronto Extremity Salvage Scale (TESS)	Quality of Life for Cancer Survivors
	Other		Modified Activity Card Sort (ACSm)		
			Other self-developed tools		
	Pain		Behavioral Risk Factor Surveillance System Survey Questionnaire	Brief Symptom Inventory	
			Other self-developed tools		
			Supportive Care Needs Survey Long Form (SCNSLF59)		
	Sexual Function		ICF cancer survivor core set		
	Weakness		6MWT		
			Short Physical Performance Battery (SPPB)		
			Sit to stand	Lateral step up test	PedsQL
			TUG		
				6MWT	Strength
	Balance	HRQOL	Functional co-morbidity index	Gait Speed	BESTest
	Cardiorespiratory Fitness	ADL/IADL/Extended IADLs	6MWT	PFTs	SF-36
		HRQOL	6MWT		
			VO2 max		

	Fatigue		Other self-developed tools		
		ADL/IADL/Extended IADLs	Multidimensional Fatigue Symptom Inventory-Short Form		
			WHODAS 2.0		
		HRQOL	EORTC Modules	EORTC QLQ-C30	ECOG
			EORTC QLQ C-30	EORTC Modules	SF-36
			Modified Tampa Scale for Kinesiophobia-Fatigue	EORTC QLQ-C30	
			SF-36	Fatigue Questionnaire (FG)	Other self-developed tools
		Pain	6MWT	SF-36	Fatigue Symptom Inventory (FSI)
	Memorial Symptom Assessment Scale				
	Sexual Function	2010 LiveStrong Foundation Survey			
	Weakness	Stair Climbing Leg Power Test	Fatigue VAS		
	HRQOL	Cancer Rehabilitation and Evaluation System (CARES)	EORTC QLQ-C30	EORTC Modules	
		EORTC Modules	European Prospective Investigation into Cancer (EPIC) physical activity questionnaire	Prostate Cancer Symptom Indices	
		EORTC QLQ C-30	EORTC Modules		
Rosenberg Self-Esteem Scale (RSES)			Personal Resource Questionnaire (
SF-12			EORTC Modules		
SF-36					
European Quality of Life-5 Dimensions (EQ-5D)	Cancer Survivors' Unmet Needs (CaSUN) Measure				

		IOC-AYA	SF-36	Brief Symptom Inventory (BSI)
		Minneapolis-Manchester Quality of Life Survey - Adolescent Form	Pediatric Quality of Life Inventory (PedsQL)	
		Other self-developed tools		
		Pediatric Quality of Life (PedsQL)	Godin Leisure-Time Exercise Questionnaire (GLTEQ)	
			Hopkins Symptom Checklist-10 (HSCL-10)	
		PROMIS	SF-36	
		QOL-CS	Quality of Life Adult Cancer Survivors (QLACS)	SF-36
		Quality of Life Questionnaire for survivors (QLQ-S)	Quality of Life Adult Cancer Survivors (QLACS)	SF-36
		SF-12	EQ-5D-5L	EORTC QLQ-C30
		SF-36	7-Day Physical Activity Recall Questionnaire (7-DPARQ)	
			EORTC QLQ-30	EORTC Modules
			EORTC QLQ-C30	Distance walked
				Fatigue VAS
			Impact of cancer (IOC) scale	
			Other self-developed tools	
			Quality of Life Index (QLI)	Assessment of Survivor Concerns (
			SF-12	
	ADL/IADL/Extended IADLs	EORTC QLQ C-30	EORTC Modules	

					Multidimensional fatigue inventory
				Fatigue Assessment Scale (FAS)	EORTC Modules
			Pediatric camp outcome measure (PCOM)		
			Pediatric Quality of Life (PedsQL)	Multidimensional Fatigue Scale	
			PROMIS		
			SF-12		
			SF-36	Brief Symptom Inventory	
				Late Life Function and Disability Index	Community Health Activities Model Seniors questionnaire
			Supportive Care Needs Survey (SCNS-SF34)		
		Cardiorespiratory Fitness	EORTC QLQ C-30	Astrand 6-minute Cycle Test	Handgrip strength
				CPET (electrically braked cycle ergometer)	
			PFTs	6MWT	
		Fatigue	EORTC QLQ C-30		
				SF-36	Tampa Scale for Kinesiophobia
			Other self-developed tools	SF-8	
			Problems and Goals (P&G) Assessment		
			Satisfaction with Life Domains Scale-Cancer	Modified Rotterdam Symptom Checklist	
			SF-36	EORTC QLQ-C30	SF-12
				Multidimensional Fatigue Inventory 20 (MFI-20)	THYCA-QoL

		HRQOL	EORTC QLQ C-30		
			SF-36	VR-12	
		Other	Brief Symptom Inventory	SF-36	
			SF-36	Brief Symptom Inventory	BMI
				Other self-developed tools	
		Pain	Brief Pain Inventory	John Henryism Active Coping Scale (JHACS)	Barriers Questionnaire (BQ-II)
		Urinary Incontinence	SF-36	SF-12	
		Weakness	6MWT	400m walk	Stair climb
			SF-36	Strength	
	Joint Mobility	Cardiorespiratory Fitness	Schedule for the Evaluation of Individual Quality of Life-Direct Weighting (SEIQoL-DW)		
	Lymphedema		Other self-developed tools		
		Cardiorespiratory Fitness	Short Physical Performance Battery SPPB	6MWT	SF-36
	Neuropathy	HRQOL	CTCAE-V3	Total Neuropathy Score	EORTC QLQ-C30
		Pain	MD Anderson Symptom Inventory - Traditional Chinese Medicine (MDASI-TCM)	SF-36	
	Pain	Fatigue	Other self-developed tools		
		HRQOL	EORTC QLQ C-30	KPS	
	Sexual Function		5 As—Ask		
		HRQOL	Sexual Functioning Questionnaire (SFQ)	Women's Health Questionnaire (WHQ)	Sexual Self-Schema (SSS) for wom
			SF-12	Pediatric Quality of Life Inventory (PedsQL)	Multidimensional Fatigue Scale

			UCLA Prostate Cancer Index (PCI)	UCLA EPIC	International Index of Erectile Function
		Pain	Pain VAS	Quick scale for sexual function	
	Urinary Incontinence	Fecal Incontinence	Other self-developed tools		
		Sexual Function	Other self-developed tools		
	Weakness		Lower-limb muscle strength	Lawton–Brody Index of instrumental activities of daily living	Brief Fatigue Inventory
		ADL/IADL/Extended IADLs	Sit to stand	1-RM	Muscle endurance
		Balance	BOT-2	M-ABC balance subtest	Berg Balance Test

* Represents studies using >3 measurement tools, this information is available through the supplemental material on-line

Abbreviations: AROM, Active Range of Motion; ADL, activities of daily living; IADL, instrumental activities of daily living;

1 Table 3. Knowledge Gaps Present in Cancer Rehabilitation Research and Clinical Practice
 2 Opportunities

Knowledge Gap	Cancer Rehabilitation Research Opportunity	Knowledge Translation/ Clinical Practice Implementation Opportunity
<i>Universal Physical Function Definition</i>	Identify gold standard tools/battery for cancer settings: Validate reliable core measures with minimal floor & ceiling, responsive to a range of cancer treatments and across the lifespan	Achieve interprofessional collaboration toward unified definition of PF, responsive to the cancer journey and able to transcend discipline-specific needs
<i>Baseline cross-sectional Physical Function assessment</i>	Expand the evidence-base on predictive and prognostic value of baseline <i>Physical Function</i> for outcomes including treatment tolerance and overall survival.	Inform surgical, medical, radiation oncology for <i>Physical Function</i> consideration during prescription of cancer treatment (modality and/or dose).
<i>Prospective Physical Function assessment, start BEFORE cancer treatment</i>	Establish value & effectiveness of cancer rehab prospective surveillance models Quantify natural history of <i>Physical Function</i> by cancer site and treatment	Provide pre-emptive education for early detection of new deficits over the course of cancer treatment; Assist radiation and medical oncologists in titrating treatment dose based on patient response.
<i>Prospective assessment focused on impact of a single agent or specific multi-modal regimen</i>	Identify mechanisms behind functional decline	Assist medical and radiation oncology colleagues in titrating dose for individual patient response.
<i>Prehabilitation</i>	Expand the evidence-base on prehab approaches as improving treatment outcomes and survival, with prehab models targeting cancer site- and treatment-specific factors, and designed to inform specifics of prescription	Implement existing evidence for prehabilitation by promoting these models as standard of care.
<i>PROMIS Physical Function Scales for Cancer</i>	Establish expanded psychometric properties for use to screen, assess, and capture change with intervention in cancer rehab	Initiate/ expand use of CAT-based measures to quantify severity of deficit and capture change to justify care.
<i>Performance-based assessment</i>	Enrich study assessments by complementing patient-reported outcomes with actual measures of performance, known to capture	Supplement patient-reported outcomes with tests less prone to intentional censorship of deficits (e.g. for fear of treatment discontinuation).

	complementary but distinct aspects of the domain.	
<i>Outcomes to Capture Physical Function Change in Response to Cancer Rehab Interventions</i>	Validate best outcomes to capture change in PF, and use in studies of interventions to rehabilitate and prehabilitate <i>Physical Function</i>	Measure and report individual PF-focused outcomes of cancer rehabilitation in provision of value-based care.

1

Accepted Prepub

1 **Figure Legends**

2 Figure 1. Frequency of Screening Measurement Tools by Cancer

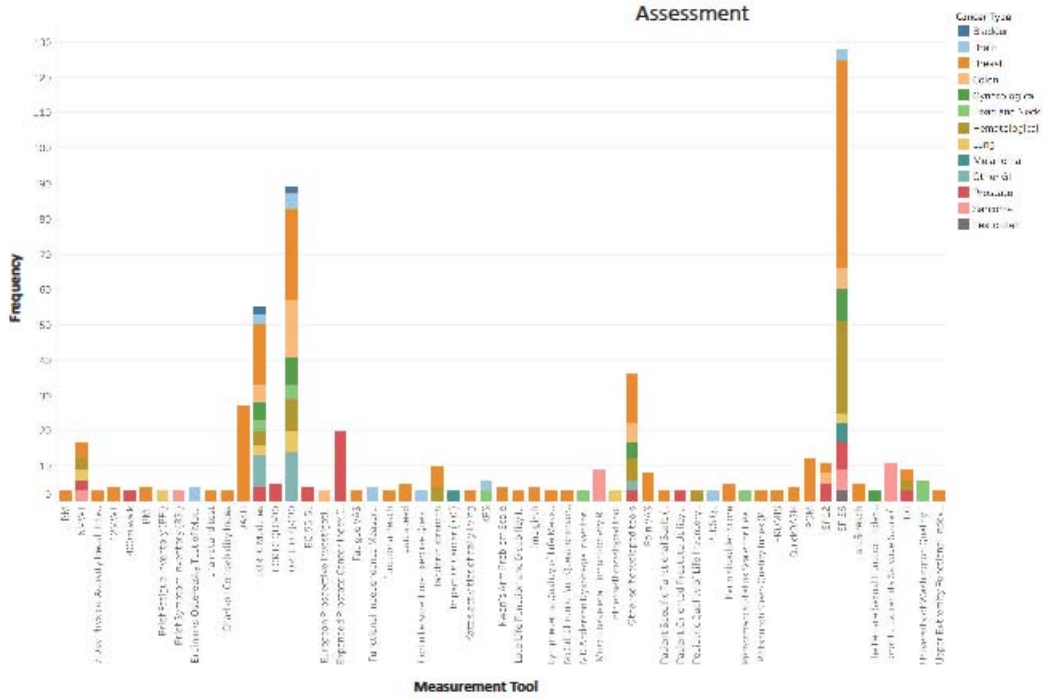
3 Figure 2. Frequency of Assessment Measurement Tools by Cancer

4 Figure 3. Frequency of Intervention Measurement Tools by Cancer

5

Accepted Prepub

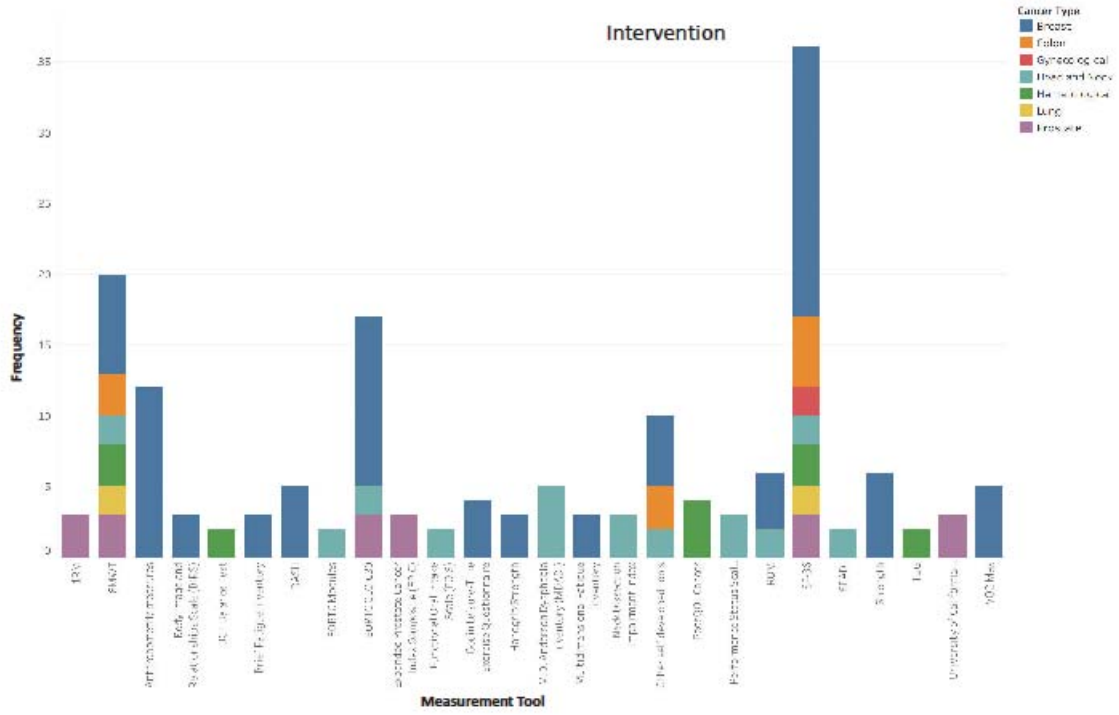
1 Figure 2. Frequency of Assessment Measurement Tools by Cancer



2
3

Accepted

1 Figure 3. Frequency of Intervention Measurement Tools by Cancer



2
3

Acccept

1 **Appendix A – Search Criteria**

2 PubMed 9369 CINAHL 4437 (after filters Human, English, Last 10 years)

3
4 (((Cancer and Survivor or survivorship)) AND (Function or functional or clinical and assessment

5 or screening or measurement OR outcomes)) AND (activities of daily living OR ambulation OR

6 amputation OR anemia OR anorexia OR arthralgia OR arthralgias OR balance OR bone density

7 OR cardiopulmonary fitness OR cardiotoxicity OR clinical OR distress OR dyspnea OR edema

8 OR oedema OR endurance OR exercise capacity OR fall OR falls OR fatigue OR fatigued OR

9 fibrosis OR fitness OR flexibility OR frail OR frailty OR function OR functioning OR functional

10 OR heart failure OR independent activities of daily living OR insomnia OR immobility OR

11 immune suppression OR impairment OR impairments OR limb salvage OR lymphedema OR

12 lymphoedema OR mobility OR morbidity OR muscle strength OR neutropenia OR neuropathy

13 OR neurotoxicity OR ototoxicity OR paresthesia OR performance status OR quality of life OR

14 pain OR paralysis OR physical performance OR physical strength OR radiculopathy OR range of

15 motion OR respiratory function OR return to work OR risk reduction OR scar OR seizures OR

16 self-care OR sensation OR sensory OR shortness of breath OR skin OR sleep OR strength OR

17 survival OR swelling OR symptom OR symptoms OR thrombocytopenia OR tissue contracture

18 OR walk OR weakness OR weight OR work OR wounds)

19