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The Prevalence of Weak Handgrip Strength in Ambulatory Oncology Patients and its Relationship with Quality of Life

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Abstract

Muscle strength as a proxy for muscle function has emerged as a predictor of nutritional status in both clinical as well as epidemiological studies. Hand grip strength (HGS) is a reliable non-invasive test of muscle strength. Dynapenia (weak strength) is independently associated with loss of physical functionality, quality of life (QoL) characteristics and reduced survival. The first aim of this study was to investigate the prevalence of dynapenia using handgrip strength (HGS) in ambulatory oncology patients and to determine if this had an impact on quality of life (QoL). This prospective cross-sectional study was conducted in the oncology day ward and outpatient clinic in Sligo University Hospital (SUH). To assess QoL, participants completed the European Organisation for Research and Treatment of Cancer Quality-of-life Questionnaire Core 30 (EORTC QLQ-C30). Isometric handgrip dynamometry was used to determine muscle strength of the dominant forearm. Three measures were performed, and the highest value was analysed. Weak handgrip strength was defined as <27kg for males and <16kg for females. Statistical analysis was conducted using SPSS version 26.0. The cohort (n=160) was predominantly female (58.1%) and breast cancer was the most prevalent cancer type (29.4%). The mean age was 63.2 ± 11.3 years. Over half of the cohort was overweight (53.5%) and 70% had not received nutritional advice from a dietician, with 77.5% reporting weight changes since diagnosis. Weak handgrip strength was present in 26.9% of the cohort. Weaker HGS was significantly associated with poorer QoL, physical, role, emotional and cognitive functioning ($p < 0.001$). Additionally, weaker HGS was associated with increased symptom scale scores for fatigue, pain, and appetite loss ($p < 0.001$). Results display how poor muscular strength impacts QoL in an ambulatory oncology setting in the North-West of Ireland. The impact of screening weak muscle strength by grip strength should assessed. This has the potential to aid timely referral to nutrition support or resistance training, which could lead to improvement of muscle strength, maintaining functional independence, and subsequently enhancing quality of life.

Keywords: Cancer; Muscle Strength; Protein malnutrition; Hand-grip Strength; Quality of life

1. Introduction

Worldwide, the association between malnutrition and cancer has become a major concern. The prevalence of malnutrition in oncology varies, with estimates from 8-85%, dependent on tumour site and definition (Kruizenga et al., 2016; Martin et al., 2015). The Global Leadership Initiative on Malnutrition (GLIM) recently developed criteria for the diagnosis of malnutrition (de van der Schueren *et al.*, 2020). The criteria states at least one phenotypic criterion and one etiologic criterion should be present. The authors of these guidelines indicated that reduced muscle is a strong phenotypic criterion with strong evidence to support its inclusion in the diagnostic malnutrition criteria. Specifically, as low muscle mass is associated with several negative clinical outcomes, such as an increased risk of readmission, longer hospital stays, disability, reduced functional capacity, loss of independence, and higher risk of mortality (Deutz *et al.*, 2019; Gariballa and Alessa, 2017).

Given the shortcomings of using BMI and weight loss to accurately assess body composition (Deutz *et al.*, 2019), there are a number of alternative, complementary tools and techniques available that can be used. There are a variety of ways to measure fat-free mass, the consensus proposes several techniques that were validated, such as dual-energy X-ray absorptiometry, bioelectrical impedance analysis, computed tomography, or magnetic resonance imaging. Nonetheless, each technique varies both in precision and availability and often these techniques may not be available at the bedside and it is important to consider alternative muscle measures.

A recent Irish review by Ryan and co-workers (2019), focused on muscle degradation in oncology and its correlation with reduced quality of life concluded with the authors emphasising the need for routine and cost-effective methods of measuring muscle in clinical settings. While measuring muscle mass can be expensive and not as routinely feasible, the measurement of muscle strength by hand-grip strength (HGS) is simple and has been rigorously tested in other clinical cohorts (Leal et al. 2010). Muscle strength as a proxy of muscle function has been widely utilized in both clinical as well as epidemiological studies as a prognostic marker (Kerr et al., 2006; Newman et al., 2006). Measuring grip strength is economical, non-invasive, and convenient for clinical settings (Bohannon 2015). If muscle strength declines first, before muscle mass and weight loss, as suggested by (Norman et al., 2011), it has the capability of identifying patients at risk of malnutrition (Flood *et al.*, 2014). It could aid timely referral to nutrition support, thus aiding in the improvement of muscle strength, reduced length of hospital stays (Kruizenga et al., 2016), improved tolerance to treatment (Capuano et al., 2010), and subsequently improved quality of life (QoL).

Dynapenia refers to the loss of muscular strength (Manini and Clark, 2011). Dynapenia as part of the pathogenesis occurs when tumour secretes pro-inflammatory cytokines, which can alter the molecular pathways resulting in muscle degradation (Burckart et al., 2010). In oncology patients, dynapenia can be multifactorial, it can be part of the pathogenesis of malignant tumour (Sanders and Tisdale, 2004), a feature of a muscle abnormality (Norman et al., 2015), an effect of the treatment prescribed (Klassen et al., 2017) or a consequence of cancer-related fatigue and consequent inactivity (Kilgour et al., 2010). Additionally, it can be a response to various non-cancer specific factors that are all influential on muscle weakness, including ageing, malnutrition, and lack of

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physical activity (Lycke et al., 2019; Kilgour et al., 2013; Ceseiko et al., 2019). A loss of muscle mass can impact activities of daily living and consequently has the potential to worsen nutritional status.

In view of the above, this research project aimed to investigate the prevalence of weak HGS in ambulatory oncology patients in the West of Ireland. A further aim was to explore the relationship between weak HGS and quality of life in this group. A better understanding of this relationship would inform more practical ways to diagnose the nutritional status of ambulatory oncology patients.

2. Materials and Methods

Ethical Approval
Ethical approval was granted by the Research and Education Foundation Ethics Committee at Sligo University Hospital.

Study design
This prospective cross-sectional study was conducted in Sligo University Hospital (SUH) between September and December 2019.

Participants
All adult (≥18 years) ambulatory patients, who were attending the oncology day ward or oncology outpatient clinic were invited to participate in the study. An information sheet explaining what the study entailed was provided for each participant. The participants were reminded that participation in the study was voluntary, and any questions were addressed. Informed signed consent was obtained before the commencement of data collection.

Data collection

Questionnaires
A general questionnaire (thirteen questions) collected demographic data (age, gender, living situation, education, employment) and oncology specific data, (cancer type, current or previous treatment, time since diagnosis). The European Organisation for Research and Treatment of Cancer Quality-of-life Questionnaire Core 30 (EORTC QLQ-C30) was used to determine QoL. It is a multidimensional questionnaire used to assess the QoL of cancer patients which includes thirteen multiple item scales. This includes an overall global health/ QoL scale, five functional scales (physical, role, cognitive, emotional, and social), seven patient symptom scales (fatigue, pain, nausea, vomiting, etc) and a financial burden scale. The EORTC QLQ-C30 subscales were calculated according to the EORTC QLQ-C30 manual and received a score from 0 to 100 (Fayers et al. 2001). For the global health status/ QoL scale and the five functional scales, a higher score indicates a higher level of quality of life and functioning. Higher scores on the seven symptom scales and the financial impact scale represent more of an impact of these symptom classes. The questionnaires were completed independently by the participants, however, if the participants needed assistance to complete the questionnaire, the questions were read to the individuals and the responses were recorded on the questionnaire by the researcher.

Anthropometry

Weight and height of all those who agreed to participate in the study were recorded by the oncology nurse. Weight was measured to the nearest 0.1 kg using a column weighing scales (Seca). Height was measured using a Seca portable stadiometer and was rounded to the nearest cm, the height in cm was then converted to m^2 by the researcher. BMI was calculated using the formula kg/m^2. BMI was classified as per World Health Organization guidelines (WHO, 2020.): < 18.5 kg/m^2 considered as underweight; > 18.5 kg/m^2 and < 25 kg/m^2considered as healthy weight; ≥ 25 kg/m^2 and < 30 kg/m^2 considered as overweight; and ≥ 30 kg/m^2 considered as obese.

Handgrip - strength

Isometric handgrip dynamometry measures the maximum isometric strength of the hand and forearm muscles. Isometric hand grip strength is strongly related with lower extremity muscle power, knee extension torque and calf cross-sectional muscle area (Cruz-Jentoft *et al.*, 2010). In our study, a spring-loaded, handgrip dynamometer (Takei 5001 Hand Grip Dynamometer-Grip A) determined isometric force of the forearm. Prior to the test being carried out, the researcher demonstrated to the participant how the test is performed, along with verbal instructions on how to conduct the test. Participants were seated with their feet fully on the floor and their shoulder neutrally rotated. The dominant arm was placed at a 90° angle with their elbow held close to their body. The dynamometer handle remained in position 2 unless the participant required this to be altered to make holding the device more comfortable. The base rested on the heel of the palm of the dominant hand, whereas the handle rested on middle of the four fingers. The non-dominant hand rested beside the body. When participants were ready, the dynamometer was squeezed with maximum isometric effort, and this was maintained for 3 s. Each participant was given one practice attempt first to get used to the device and then three measures using the dominant hand were recorded. Participants were instructed to restrict other body movement and to give maximal effort for each attempt. The test was repeated within 30 s and values reached were recorded to the nearest 0.5 kg. Weak muscle strength (dynapenia) was defined as a handgrip <27 kg for men and <16 kg for women (Cruz-Jentoft et al., 2018).

Statistical Analysis

Statistical analysis was performed using the statistical package for social science (SPSS - version 26.0, 2019, SPSS Inc., Chicago, IL, USA). The mean ± SD is presented for continuous data, the frequency and percentage for categorical data and the medians and interquartile range (IQR) for non-normally distributed data. HGS data was not normally distributed as tested by Shapiro–Wilk's test and therefore a non-parametric test (Mann-Whitney) was used. To test for associations between variables chi-squared was used for categorical data, one-way analysis of variance for normally distributed continuous data and Mann–Whitney tests for continuous data that were not normally distributed (Cognitive and Social Functioning). Student's Independent Samples T-test was used to test statistical significance of normally distributed QoL scales between the two HGS groups. Levene's test determined that the assumption of homogeneity of variance was met. Bonferroni adjusted p-values were used for all post-hoc tests. All statistical tests were two-sided, and p-values are reported to two decimal places. Significance was taken at the level of $p < 0.05$.

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3. Results

In total, 160 individuals were recruited, overall, an 85.3% response rate. The cohort was predominantly female (n= 94, 58.1%), with breast cancer as the most prevalent cancer type (n=47, 29.4%), followed by colorectal malignancies (20.4%). The age range was 34-83 years old, with a mean age of 63.2±11.3 years. Nearly half of the cohort were retired (n=75, 46.9%). Mean BMI was 26.7 ± 6.0 kg m^2 and over half of the respondents were classified as overweight or obese (n=94, 53.3%). Recent weight loss (within previous six months) was reported by 37.5% of the cohort (*n* = 60), with weight gain being reported in an additional 40% (*n* = 64). Over two thirds of the cohort were receiving chemotherapy treatment and near to one third were not receiving any treatment. From the total cohort, 26.9% (n=43) of patients had dynapenia. Between the normal and weak HGS groups, there was a statistical significance difference in strength, ($p<0.001$). Predominantly, those who had weak HGS were in the 70+ age category (n=19, 45.3) and consisted of patients who were still receiving treatment (Table 1).

Table 1: Demographic and clinical characteristics of the study cohort and broken down by normal HGS and weak HGS (dynapenia).

Demographics		**n**	**Total n = 160**	**Normal HGS *n* = 117**	**Weak HGS (dynapenia) *n*= 43**
Gender *n (%)*	Male	160	66 (41.9)	47 (40.2)	19 (45.2)
	Female		94 (58.1)	70 (59.8)	24 (54.8)
Age (years), Mean (SD)		160	63.2±11.3	62.5±11	65.2±12.1
Age group (years) *n (%)*	34-49	160	15 (9.4)	11 (9.4)	4 (9.5)
	50-59		48 (30.0)	38 (32.5)	10 (23.8)
	60-69		41 (25.6)	31 (26.5)	10 (21.4)
	70+		56 (35.0)	37 (31.6)	19 (45.3)
Handgrip strength (kg) Median (IQR)		160	25 (14)	30 (12)	20 (7.0) *
Time from diagnosis (years), Mean (SD)		159	3.9±4.8	3.8±4.9	4.2±4.5
Primary tumor, n (%)	Breast	159	47 (29.4)	33 (28.2)	14 (33.3)
	Colorectal		32 (20.0)	24 (20.5)	8 (19.0)
	Hematologic		21 (13.1)	11 (9.4)	10 (23.8)
	Upper GI		17 (10.6)	14 (12.0)	3 (7.1)
	Lung		14 (8.8)	11 (9.4)	3 (4.8)

	Gynecologic		13 (8.1)	11 (9.4)	2 (4.8)
	Prostate + Testicular		9 (5.7)	3 (7.7)	0 (0.0)
	Other		6 (3.8)	4 (3.4)	2 (7.2)
Current treatments [(a)] *n (%)*	Chemotherapy	160	100 (62.6)	72 (62.4)	26 (60.5)
	Radiotherapy		8 (5.0)	6 (4.3)	2 (4.7)
	Hormonal Therapy		17 (10.6)	12 (7.7)	5 (11.6)
	No current treatment		40 (25.0)	30 (25.6)	10 (23.2)
Education completed *n (%)*	Less than second level	158	31 (19.5)	16 (9.4)	15 (35.7)
	Completed second level		82 (52.2)	62 (36.3)	20 (47.6)
	Bachelor's Degree		35 (22.0)	28 (16.3)	7 (16.7)
	Graduate School (Master's/Doctorate)		10 (6.3)	10 (5.85.8)	0 (0.0)
Employment Status *n (%)*	Full-time	160	40 (25.0)	32 (27.4)	8 (19)
	Part-time		7 (4.4)	4 (3.4)	3 (7.1)
	Unemployed		14 (8.8)	10 (8.5)	4 (9.5)
	Homemaker		8 (5.0)	6 (5.1)	2 (2.4)
	Retired		75 (46.9)	53 (45.3)	22 (52.4)
	Sick Leave		16 (10.0)	12 (10.3)	4 (9.5)
BMI (kg/m^2), Mean (SD)		154	26.7±6.0	27±6.3	25.3±5.1
BMI classification, *n (%)*	Underweight	154	9 (5.8)	5 (4.4)	4 (10.0)
	Healthy Weight		51 (33.1)	34 (30.1)	17 (40.0)
	Overweight		61 (31.9)	50 (44.2)	11 (27.5)
	Obese		33 (21.4)	24 (21.2)	9 (22.5)
Experienced weight loss in last 6 months, n (%)		160	60 (37.5)	45 (38.5)	14 (33.3)
Experienced weight gain in last 6 months, n (%)		160	64 (40.0)	45 (38.5)	19 (45.2)
Seen or been referred to a dietitian, n (%)		160	48 (30.0)	36 (30.8)	12 (28.6)

[a] Several patients were receiving more than one type of current treatment; therefore, the total is ≠ to 100%.

* A Mann-Whitney U test indicated a statistical significance between HGS groups ($p<0.001$)

Table 2 shows for both genders there was a significance between the first three quartiles and 100th HGS quartile (p <0.001). Additionally, there was a statistical significance in HGS for each quartile (p <0.001).

Table 2: Demographic and clinical characteristics presented by HGS quartiles.

Demographics		n	Handgrip strength (kg) Quartiles 25th *N = 53*	50th *N = 33*	75th *N = 38*	100th *N =36*
Gender *n (%)*	Male	160	10 (18.9)	6 (18.2)	21 (55.3)	30 (83.3) *
	Female		43 (81.1)	27 (81.1)	17 (44.7)	6 (16.7) *
Age (years), Mean (SD)		160	65.2±12.6	60.0±9.2	61.7±12.2	64.0±9.5
Age group (years) *n (%)*	34-49	160	7 (13.2)	3 (9.1)	4 (10.5)	1 (2.8)
	50-59		11 (20.8)	13 (39.4)	15 (39.5)	9 (25.0)
	60-69		8 (15.1)	12 (36.4)	7 (18.4)	13 (36.1)
	70+		27 (50.1)	5 (15.1)	12 (31.5)	13 (36.1)
Handgrip strength (kg) Median (IQR)		160	18 (4.0) **	23 (3.0) **	29.5 (3.0)**	38 (9.0) **
Time from diagnosis (years), Mean (SD)		159	3.9±4.0	2.8±2.6	3.9±4.4	4.5±6.4
Primary tumor, n (%)	Breast	159	21 (40.4)	14 (42.4)	11 (28.9)	1 (2.8)
	Colorectal		3 (5.8)	5 (15.2)	9 (23.9)	16 (44.4)
	Hematologic		7 (13.3)	1 (3.0)	8 (20.8)	5 (14.0)
	Upper GI		5 (9.5)	3 (9.1)	3 (7.8)	6 (16.6)
	Lung		7 (13.3)	5 (15.2)	2 5.2)	0 (0.0)
	Gynecologic		4 (7.7)	4 (12.0)	1 (2.6)	2 (5.6)
	Prostate + Testicular		3 (5.8)	1 (3.0)	1 (2.6)	4 (11.1)
	Other		2 (3.8)	0 (0.0)	3 (7.8)	2 (5.6)
Current treatments [(a)] *n (%)*	Chemotherapy	160	31 (58.5)	25 (75.8)	22 (57.9)	22 (55.6)
	Radiotherapy		4 (7.6)	2 (6.0)	0 (0.0)	2 (5.6)
	Hormonal Therapy		7 (13.2)	4 (12.1)	5 (13.2)	1 (2.8)
	No current treatment		14 (26.4)	4 (12.1)	11 (28.9)	11 (30.8)
		158	15 (28.3)	3 (12.5)	5 (13.2)	8 (22.2)

Education completed *n (%)*	Less than second level					
	Completed second level		23 (43.4)	15 (46.9)	22 (57.9)	22 (61.1)
	Bachelor's Degree		13 (24.5)	11 (34.4)	7 (18.4)	4 (11.1)
	Graduate School (Master's/Doctorate)		2 (3.8)	2 (6.3)	4 (10.5)	2 (5.6)
Employment Status *n (%)*	Full-time	160	6 (11.3)	12 (36.3)	14 (36.8)	8 (22.2)
	Part-time		2 (3.8)	2 (6.1)	2 (5.3)	1 (2.8)
	Unemployed		5 (9.4)	2 (6.1)	2 (5.3)	5 (13.9)
	Homemaker		1 (1.9)	4 (12.1)	1 (2.6)	1 (2.8)
	Retired		32 (60.4)	10 (30.3)	15 (39.5)	19 (52.8)
	Sick Leave		7 (13.2)	3 (9.1)	4 (10.5)	2 (5.6)
BMI (kg/m^2), mean (SD)		154	25.8±6.5	27.0±6.4	26.3±7.1	28.2±3.5
BMI classification, n *(%)*	Underweight	154	6 (11.5)	0 (0.0)	2 (5.3)	0 (0.0)
	Healthy Weight		17 (32.7)	16 (48.5)	12 (31.6)	6 (13.9)
	Overweight		15 (28.8)	7 (24.2)	18 (47.4)	21 (58.3)
	Obese		11 (21.2)	8 (24.2)	7 (18.5)	10 (27.8)
Experienced weight loss in last 6 months, n (%)		160	14 (26.4)	16 (48.5)	17 (44.7)	12 (33.3)
Experienced weight gain in last 6 months, n (%)		160	24 (45.3)	12 (36.4)	16 (42.1)	12 (36.1)
Seen or been referred to a dietitian, n (%)		160	15 (28.3)	10 (30.3)	11 (28.9)	12 (33.3)

* Post hoc comparisons using the Bonferroni correction indicated that for both genders there was a significance between the first three quartiles and 100th HGS quartile (p <0.001)

** Indicates level of significance between the median HGS for each quartile.

Quality of life analysis by HGS categories

The mean global health status/QoL score of the cohort was 65.7 ± 21.2, with a possible maximum score of 100. This score was significantly lower in patients with weaker HGS (<0.001). This was also true for physical, role, emotional and cognitive functioning (<0.001). For symptom scales, scores with a higher result indicated a higher symptom burden. The highest symptom scores were for fatigue (mean±SD: 32.9 ± 26.7), and there was a significant difference in the fatigue scores between the two HGS groups (<0.001*)*. Pain and appetite loss were also significantly higher in those with weaker HGS (<0.001). (Table 2)

Table 3: The EORTC QLQ-C30 quality of life scales for the total group and by normal and weak HGS groups

EORTC QLQ-C30 Scales	Total n=160	Normal HGS *n* = 117	Weak HGS (dynapenia) *n*= 43	*P*-value
Global health status / QoL	65.7 ± 21.2	67.9 ± 20.8	59.5 ± 21.4	<0.001
Physical functioning Mean (SD)	78.5 ± 20.8	80.9 ± 19.5	71.4 ± 23.0	<0.001
Role functioning Mean (SD)	74 ± 29.3	76.8 ± 27.3	65.5 ± 33.3	<0.001
Emotional functioning Mean (SD)	79.3 ± 22.9	84.5 ± 21.0	75.7 ± 27.3	<0.001
Cognitive functioning Median (IQR)	80.5 ± 22.9	100 (33.3)	83.3 (33.3)	<0.001
Social functioning Median (IQR)	74 ± 27.9	83.3 (33.3)	83.3 (33.3)	0.06
Symptom Scales**				
Fatigue Mean (SD)	32.9 ± 26.7	29.2 ± 25.9	42.3 ± 26.6	<0.001
Nausea/vomiting Mean (SD)	8.3 ± 19	8.7 ± 20.4	7.5 ± 20.4	0.25
Pain Mean (SD)	20.8 ± 30.6	17.0 ± 27.9	32.2 ± 35.4	<0.001
Dyspnoea Mean (SD)	18.6 ± 25.5	17.8 ± 26.0	20.6 ± 24.4	0.98
Insomnia Mean (SD)	31 ± 36.7	29.4 ± 36.2	36.5 ± 38.1	0.94
Appetite loss Mean (SD)	14.6 ± 27.2	10.5 ± 23.4	26.4 ± 33.5	<0.001
Constipation Mean (SD)	14 ± 27.6	12.0 ± 25.0	19.8 ± 33.8	0.52
Diarrhoea Mean (SD)	10 ± 22.4	10.5 ± 22.6	8.7 ± 22.2	0.37
Financial difficulties Mean (SD)	14.6 ± 24.7	16.0 ± 25.0	11.1 ± 24.0	0.40

*For functional scales and QoL, higher scores indicate higher functioning.

**For symptom scales, higher scores indicate impaired functioning

4. Discussion

This study identified dynapenia in over a quarter (26.9%) of our cohort of ambulatory oncology patients in the West of Ireland. Predominantly, those with weaker HGS were female (54.8%) and still receiving treatment (62.1%). Our findings highlight that weak HGS can be present in ambulatory oncology patients, and this can be associated with decreased QoL characteristics. Those with weaker HGS had impaired physical, role, emotional and cognitive functioning (all $p<0.001$) and were more likely to experience fatigue, pain, and appetite loss (all $p<0.001$). This study reports similar findings to a recent oncology study (n=158) where 23.4% had dynapenia present. (Rechinelli et al., 2020). In Rechinelli et al's study, the cohort had an average age of 59.5 ± 14.0 year and used the same dynapenia cut-off points as defined in our study (women < 16 kg and for men < 27 kg).

Previous studies show how low HGS is prevalent (70%) in admitted advanced cancer inpatients (Kilgour et al., 2013; Norman et al., 2010), in 64.2% of older cancer patients (mean age 79 years) (Lycke et al., 2019), in 32.8% cancer patients following surgery (Sato et al., 2015; Chen et al., 2011) and in approximately 20% of cancer survivors (Paek and Choi, 2019; Benavides-Rodríguez et al., 2017). The findings of this study are relevant in the field of oncology as there is a lack of data on HGS in ambulatory oncology patients and early detection could aid combat any negative malnutrition effects such as increased length of stay in hospital (Kruizenga et al., 2016), increased risk of post-surgery complications (Sathianathen et al., 2019) and decrease in response to treatment (Capuano et al., 2010), all of which can impact QoL. Lack of data – need for research to determine – impact. Clinically

As evident in the literature, cancer is negatively associated with QoL (Capuano et al., 2010). The mean Global Health Status score in our cohort was 65.7 ± 21.2, which is slightly higher than the reference value of 61.3 ± 24.2 provided by the EORTC (for all cancer types and all stages) (Scott et al., 2008). This was significantly different between those with normal HGS and weak HGS. Our findings also show those with weaker HGS scored significantly lower on physical, role, emotional and cognitive functioning scales (all $p<0.001$). Comparable, Kilgour et al., had findings of decreased QoL and physical functioning scores in cancer patients with the weakest HGS, however this was in advanced oncology patients, and it used the McGill QoL questionnaire (Kilgour et al., 2013). In a study conducted by Norman et al patients with GI tract cancer cachexia had lower HGS which correlated to lower QoL status and decreased physical functioning (Norman et al., 2012).

In our cohort, those with weak HGS had statistically significantly higher scores for three (fatigue, pain, and appetite loss) symptom scales of the EORTC QLQ-C30. Of these symptoms, fatigue was the most prevalent symptom for the whole cohort, but it particularly affected those with dynapenia. In oncology, cancer related fatigue (CRF) is the most common and debilitating of symptoms experienced by patients, affecting 50-90% of cancer patients (Charalambous and Kouta, 2016; Ann et al., 2015; Campos et al., 2011). In a cross-sectional qualitative study on CRF and quality of life, patients undergoing chemotherapy described the profound impacts on their lives that were reflected through the following themes: "dependency on others," "loss of power over decision making," and "daily living disruption" (Charalambous and Kouta, 2016). Over two-thirds of our cohort were still receiving chemotherapy which can intensify the impact of CRF (Thong et al., 2020).

The term "appetite loss" is often observed as an indicator of QoL in oncology (Shragge et al., 2006). Appetite loss is independently associated with survival and links to physical function (Lis, Gupta, and Grutsch, 2008). In this study, the appetite loss score was two-fold higher in patients with the weaker HGS. This nutritional impairment can adversely affect dietary intake, which can lead to loss of muscle mass and strength and consequently, to a deterioration of nutritional status (Clark and Manini, 2012).

Regarding clinical implications, reduced strength in oncology is associated with malnutrition (Balci et al., 2018), weight loss (Ryan et al., 2019), sarcopenia (Ryan et al., 2019), pre-cachexia, cancer cachexia (Ryan et al., 2016) and mortality (Chen et al., 2011). If hand grip dynamometry was introduced as a proxy to identify cancer patients with reduced strength, it could aid timely referral for support in a clinical setting before the likelihood of clinical implications such as longer hospital stays, reduced functional capacity and loss of independence (Deutz et al., 2019). Targeted multimodal interventions are recommended, cancer rehabilitation programs have successfully shown how exercise and strength training are effective improving muscular strength (Christensen et al., 2014). A recent study investigated the success of strength training in health related QoL in women with newly diagnosed breast cancer, the results of the study showed how the training was well tolerated and safe, improving overall strength, increasing QoL by 13% and reducing fatigue by 25% (Ceseiko et al., 2019). In another study, in prostate cancer patients, upper body strength improved by 22% after 24 weeks of resistance training, and after 17 weeks of strength training early-stage breast cancer patients improved strength by 25-35% (Courneya et al., 2007; Segal et al., 2009). Norman et al., carried out a three-month nutritional intervention with protein and energy rich supplements in malnourished GI patients, with a control group given only dietary advice. Results showed functional status, HGS and QoL improved in the intervention group (Norman et al., 2008).

Current recommendations for protein in cancer patients is 1-1.5g/kg/d (Arends et al., 2017); evidence shows how 50% of cancer patients do not meet this recommendation (Prado et al., 2012). A noteworthy finding in our study was since cancer diagnosis, 70% of the total cohort report receiving no nutritional advice from a registered dietitian, with 36.9% and 40.6% reporting weight loss and gain, respectively. Additionally, in a recent national oncology study 52% of the cohort self-reported personal muscle loss (Sullivan *et al.*, 2021). Combined, these results emphasize and reflect the urgent need for more registered oncology dietitians in Ireland, as currently there is one dietitian per 4,500 oncology patients.

This study had several limitations, a heterogeneous cohort resulted in differences in cancer type, time since diagnosis and the clinic attended. However, this heterogeneity is a representation of regular clinical practice, and highlights how the use of HGS in identifying patients at risk of a poorer QoL can be utilized in a real-world clinical setting. The participants were predominately female, this factor was out of our control, as more females presented in the clinics than males. There was an imbalance in the number of patients recruited from the oncology day ward and outpatients. If the study was to be repeated, higher numbers of outpatients should be included if possible, however time spent on site is much lower for outpatients, making recruitment in this setting more challenging. In addition, more patients presented in the oncology day ward. The study did not collect direct information regarding exercise or physical activity, however, EORTC QLQ-C30 incorporates this into the functioning scales. As this was a cross-sectional study, the aetiology of weak HGS cannot be confirmed; furthermore, some participants may have just started or finished treatment, which could have influenced muscle strength and their nutritional status may have changed quite quickly in the proceeding months.

5. Conclusions

This study found a 26.9% prevalence of dynapenia in a cohort of Irish ambulatory cancer patients and that this was associated with impaired physical, role and cognitive functioning and increased symptom burden scores for fatigue, pain, and appetite loss.

Early detection by incorporation of routine screening of muscle strength in clinical practice has the capability of identifying patients at risk of poorer clinical implications. This has the potential to aid timely referral to nutrition support or resistance training, which could lead to improvement of muscle strength, maintaining functional independence, and subsequently enhancing quality of life.

6. Future Work

Previously discussed research studies showed how the measurement of HGS could be a part of daily clinical practice, as it is inexpensive, reliable, and feasible in routine practice (Bohannon, 2015). Future work should determine if the early identification of weak muscle strength by grip strength could be improved by timely referral to resistance training and nutritional support and the long-term clinical impacts this could have should be measured.

7. Author Contributions

LK conceived the study and was responsible for the methodology. NO'C and AO'S were responsible for data collection and with LK were responsible for data curation. LK and CMcH were responsible for supervision. NOC was responsible for visualisation. NOC was responsible for writing the original draft, as well as review and editing.

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