ORIGINAL RESEARCH

Grip strength, functional capacity, and quality of life of individuals with cancer

Força de preensão, capacidade funcional e qualidade de vida de indivíduos com câncer

Fuerza de agarre, capacidad funcional y calidad de vida de personas con cáncer

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ABSTRACT | This study aims to evaluate strength, functional capacity, and quality of life in individuals with cancer, compared with predicted values of healthy individuals, as well as to determine whether strength and functional capacity predict quality of life in this population. Fifty individuals with cancer were evaluated according to strength (dynamometer Crown), functional capacity (*Glittre* ADL test) and quality of life (SF-36). Results were compared with predicted reference values for healthy individuals, matched for age and gender, by the two-sample Kolmogorov-Smirnov test. Spearman's correlation coefficient was used to evaluate the correlations between variables. Multiple linear regression was used to investigate whether strength and functional capacity predict quality of life. There is significant difference ($p<0.01$) for strength, functional capacity, and quality of life, between individuals with cancer and the predicted in healthy individuals. There was a significant correlation between strength and functional capacity ($\rho=-0.58$; $p<0.01$), strength and quality of life ($\rho=0.46$; $p<0.01$), and quality of life and functional capacity ($\rho=-0.51$; $p<0.01$). Regression analysis showed that functional capacity is a predictor of quality of life and, alone, can explain 20% ($R^2=0.195$) of this variable. Thus, individuals with cancer showed significant decrease in strength, functional capacity, and quality of life, when compared to predicted values. Moreover, all these variables are correlated, mainly functional capacity and quality of life.

Keywords | Neoplasms; Hand Strength; Exercise; Quality of Life.

RESUMO | O objetivo deste estudo foi avaliar a força, capacidade funcional e qualidade de vida de indivíduos com câncer em comparação com valores preditos em indivíduos saudáveis, bem como determinar se força e capacidade funcional são capazes de predizer a qualidade de vida dessa população. Foram avaliados 50 indivíduos com câncer, de acordo com força (dinamômetro Crown), capacidade funcional (teste de AVD-*Glittre*) e qualidade de vida (SF-36). Os resultados foram comparados aos valores de referência preditos em indivíduos saudáveis, pareados por idade e sexo, pelo teste *two-sample Kolmogorov-Smirnov*. O coeficiente de correlação de Spearman foi utilizado para avaliar as relações entre as variáveis, e a regressão linear múltipla foi utilizada para avaliar se força e capacidade funcional são capazes de predizer a qualidade de vida. Houve diferença significativa ($p<0,01$) para força, capacidade funcional e qualidade de vida entre indivíduos com câncer e o predito em indivíduos saudáveis. Bem como, uma correlação significativa entre força e capacidade funcional ($\rho=-0,58$; $p<0,01$), entre força e qualidade de vida ($\rho=0,46$; $p<0,01$), e qualidade de vida e capacidade funcional ($\rho=-0,51$; $p<0,01$). A análise de regressão demonstrou que a capacidade funcional é preditora da qualidade de vida, sendo capaz, sozinha, de explicar 20% ($R^2=0,195$) dessa variável. Assim, indivíduos com câncer apresentaram diminuição significativa na força, capacidade funcional e qualidade de vida se comparados ao predito. Além disso, todas essas variáveis estão correlacionadas em

indivíduos com câncer, principalmente, a capacidade funcional e a qualidade de vida.

Descritores | Neoplasia, Força Muscular; Exercício; Qualidade de Vida.

RESUMEN | El objetivo de este estudio fue evaluar la fuerza, la capacidad funcional y la calidad de vida de los individuos con cáncer en comparación con los valores pronosticados en individuos sanos, así como determinar si la fuerza y la capacidad funcional son capaces de predecir la calidad de vida de esta población. Se evaluaron a cincuenta individuos con cáncer según la fuerza (dinamómetro Crown), la capacidad funcional (prueba de AVD-*Glitro*) y la calidad de vida (SF-36). Los resultados se compararon con los valores de referencia predichos en individuos sanos, pareados por edad y sexo, por la prueba *two-sample Kolmogorov-Smirnov*. Se utilizó el coeficiente de correlación de Spearman para evaluar las relaciones entre las variables, y la regresión lineal múltiple para evaluar si la fuerza y la capacidad funcional son capaces de predecir la calidad de vida. Hubo una diferencia significativa ($p<0.01$) para la fuerza, la capacidad funcional y la calidad de vida entre los individuos con cáncer y la predicha en los individuos sanos. Además de una correlación significativa entre fuerza y capacidad funcional ($\rho=-0.58$; $p<0.01$), fuerza y calidad de vida ($\rho=0.46$; $p<0.01$), y calidad de vida y capacidad funcional ($\rho=-0.51$; $p<0.01$). El análisis de regresión mostró que la capacidad funcional es predictora de la calidad de vida, pudiendo explicar, por sí sola, el 20% ($R^2=0.195$) de esta variable. Así los individuos con cáncer tuvieron una disminución significativa en la fuerza, la capacidad funcional y la calidad de vida en comparación con lo predicho. Además, todas estas variables están correlacionadas con individuos con cáncer, sobre todo la capacidad funcional y la calidad de vida.

Palabras clave | Neoplasia, Fuerza Muscular; Ejercicio; Calidad de vida.

INTRODUCTION

Cancer has as its main characteristics the growth and proliferation of irregular cells, which multiply until they form a cluster entitled tumor[1]. When malignant, the tumor makes the body's activities impossible, and it alters the path of food and blood supply of regular cells[1]. Its growth is not controlled and can lead to the death of the individual[2]. The causes are not fully understood, but there are factors that can increase their onset, such as obesity and smoking[2]. According to the World Health Organization (WHO), in 2018, cancer was the second leading cause of death in the world, responsible for about 9.6 million deaths, second only to cardiovascular diseases[3].

The most common cancer treatments are surgery, radiotherapy, and systemic therapy[4]. Within systemic therapy, chemotherapy, and immunotherapy are the best known[4]. Chemotherapy consists of the use of drugs that act at the cellular level, impairing the growth and multiplication of cancer cells[5]. However, such chemotherapy agents do not present preference only for tumor cells, being toxic to all tissues of rapid proliferation of the human body, thus affecting the individual's organism in general[5]. Among the complications faced by individuals with cancer, due to treatment, muscle weakness stands out[6]. The apparent causes for this condition would be increased energy expenditure rate, increased protein degradation process by enzymes associated with decreased protein synthesis, and increased lipolysis[7]. Muscle weakness in this population can result in longer hospitalizations stay and shorter survival, in addition to reduced functional capacity, and worse quality of life[8].

The term "ability" describes an individual's ability to perform a task or action in a standardized environment, and therefore the construct functional capacity aims to indicate the maximum likely level of functionality that the individual is able to achieve in a certain domain at a given time[9]. On the other hand, quality of life can be defined as the perception that the individual has about their own living condition, within the context of culture and value system, considering their life goals, expectations, concerns, limitations, and restrictions[10]. Restricted physical function, together with other symptoms found in this population, such as pain, nausea and vomiting, depression, among others[11,12], can lead to an impairment of functional capacity and quality of life of individuals with cancer, as well as generating a vicious circle[13,14].

Thus, establishing the magnitude of the losses of strength, functional capacity, and quality of life of individuals with cancer, compared with healthy individuals — besides defining a possible relationship between these variables — is fundamental for the rehabilitation of these people. In this context, previous

studies aimed to investigate the muscle strength of individuals with cancer, comparing them with healthy individuals[15-17]. However, while Harrington et al.[15] and Niederer et al.[17] found a significant difference in the strength of the upper limbs and quadriceps of individuals with cancer in relation to healthy individuals, another study did not find significant difference in hand strength and knee extensors in this population, when compared to healthy individuals[16]. These contradictory results reaffirm the need for further studies on the subject. Regarding functional capacity and quality of life, no studies were found comparing individuals with cancer and healthy individuals, or even with predicted values.

This study evaluates the strength, functional capacity, and quality of life of individuals with cancer compared to predicted values in healthy individuals, in addition to investigating possible correlations between these variables, and it aims to determine whether strength and functional capacity are capable of predicting the quality of life of this population.

METHODOLOGY

This is a cross-sectional observational study carried out at the Higher Education Foundation of Itabira (*Fundação Comunitária de Ensino Superior de Itabira* — FUNCESI).

Participants

Participants were recruited from the Itabira Oncological Center (*Centro Oncológico Itabira* - COI) and in the community in general, from August to October 2019. For collection in the IOC, the coordinator signed a letter consent, authorizing the study with the patients of the center. For inclusion in the study, the participants met the following criteria: (1) individuals of both sexes, without age restriction; (2) individuals diagnosed with cancer, regardless of the time of diagnosis or *place of involvement*; (3) Be able to perform all tests. Participants who indicated or presented physical, functional and/or mental situations that could hinder or interfere with the results of the tests were excluded. All participants signed the informed consent form

Procedures

Initially, demographic and clinical data from the participants were collected in order to characterize

the sample. Subsequently, after analyzing the inclusion criteria and signing the consent form, the following outcome measures were collected: handgrip strength, functional capacity, and quality of life. All collections were carried out in the auditorium of the Hospital Nossa Senhora das Dores and at the Funcesi School Clinic.

Grip strength

Grip strength was evaluated by the manual dynamometer (Crown, with 50kgf capacity) which, according to previous studies, can be used as an indicator of the individual's overall strength[18]. During the collection, the individual remained seated in a chair without arm rest, with the spine upright, knees held in 90º flexion, shoulders with adduction positioning and neutral rotation, with elbow flexion at 90º, forearm in neutral, and wrist with a slight extension of 30º[19]. The evaluation was performed alternately between the dominant and non-dominant hand, with three measurements for each side[19]. The highest value found was recorded for each individual. The results were compared to the reference values predicted in healthy individuals, matched by age and sex[20].

Functional capacity

Functional capacity was evaluated using the Glittre ADL (TGlittre) test. In this test, starting from the sitting position, the individuals were instructed to get up and walk through a 10m corridor, passing a staircase, which is in the middle of this corridor, until they reach a shelf. The shelves are positioned at the height of the shoulder girdle and pelvic girdle. The individual must move three weights, one kilogram (kg) each, from the top shelf to the lowest shelf and then to the floor. Then, the individual should perform the reverse sequence, so that each weight should be placed back on the top shelf. Then, the individual returns through the corridor, until sitting in the chair and restarting the route. The test ends when the individual completes five courses. The individuals are allowed to rest during the testing, however, they are instructed to return to the activity as soon as possible. No incentive is given during the course, and individuals should wear a backpack containing a weight of 2.5kg (women) or 5kg (men). The outcome variable is the time spent to finish the test[21-23]. Blood pressure, heart rate, oxygen saturation, and fatigue were measured with the individual at initial rest, at the end of the test and five minutes after the end of the test. The values found in individuals with

cancer were compared to those predicted in healthy individuals[24].

Quality of life

Quality of life was assessed using the generic Short Form Health Survey (SF-36), covering eight domains: functional capacity, physical limitation, pain, general health status, vitality, social aspects, emotional aspects, and mental health[25]. The SF-36 is applied as an interview and its score ranges from 0 to 100, and the higher the value found, the better the individual's quality of life. The values identified in individuals with cancer were also compared to those predicted in healthy individuals, matched by age and sex[26].

Sample estimation

The sample estimation was based on the correlation coefficients between variables, found in a pilot study with 10 individuals. Considering a 0.05 alpha, a power of 0.90 and assuming the lowest coefficient found in the pilot(ρ=0.40), between functional capacity and quality of life, the required sample would be 50 individuals[27]. This sample size is also sufficient for regression analysis, considering the insertion of two independent variables (grip strength and functional capacity), since the equation used for the estimation would be $n=30+10k$, where "k" represents the number of possible predictor variables to be included[28].

Statistical analysis

Descriptive statistics and normality tests (*Kolmogorov-Smirnov*) were performed for all variables. The *Kolmogorov-Smirnov two-sample* test was used to evaluate the difference between the values found in individuals with cancer and the predicted values in healthy individuals. Spearman's correlation coefficient was used to analyze the correlations between handgrip strength, functional capacity, and quality of life. The strength of the correlations was classified as low (ρ<0.30), moderate (0.30≤ρ≤0.50), and high(ρ>0.50)[29]. Multiple linear regression, *stepwise method,*, was used to evaluate which variable(s) is(are) able to predict the quality of life of this population. All analyses were performed with the statistical software SPSS 23.0, with 5% significance level.

RESULTS

Characteristics of the participants

Out of the 161 individuals invited to participate in the study, 95 refused or did not fit the inclusion criteria, and 16 did not attend the scheduled evaluation, due to mobility issues. Thus, the total sample was composed of 50 participants (Figure 1), 19 (38%) men. The mean age of the participants was 59 years old and standard deviation (SD) 12. In total, 11 types of cancer were found, with the highest prevalence of breast cancer 26 (52%) and prostate cancer 9 (18%), followed by rectal 4 (8%), stomach 2 (4%), and pancreas cancer 2 (4%). The treatments that the subjects were submitted were: chemotherapy 40 (80%), hormone therapy 7 (14%), and radiotherapy 3 (6%). The mean time since cancer diagnosis was 21 months (SD 19). The general characteristics of the participants are found in Table 1.
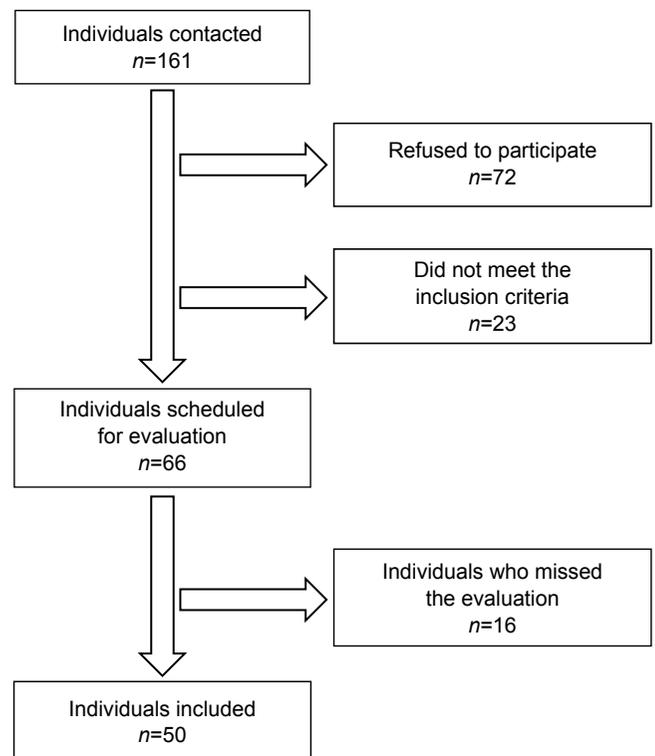

Figure 1. Flowchart of the participants' inclusion (n=50)

Table 1. Characteristics of the participants (*n*=50)

Age (years) and mean (SD)	59 (12)
Sex, man, number (%)	19 (38)

(continues)

Table 1. Continuation

Location of the tumor (%)	
Breast	26 (52)
Prostate	9 (18)
Stomach	2 (4)
Pancreatic	2 (4)
Bowel	4 (8)
Esophageal	1 (2)
Liver	1 (2)
Lung	1 (2)
Bowel	1 (2)
Womb	1 (2)
Brain	1 (2)
Ovarian	1 (2)
Treatment (%)	
Chemotherapy	40 (80)
Hormone therapy	7 (14)
Radiotherapy	3 (6)
Time since diagnosis (months), mean (SD)	21 (19)

SD: standard deviation.

Difference between the values found in individuals with cancer and the predicted values in healthy individuals

A significant difference was found (p<0.001) between handgrip strength of individuals with cancer (mean 25, SD 9) and the predicted values in healthy individuals (mean 29, SD 8). A significant difference was also identified (p<0.01) regarding functional capacity between the values of the sample (mean 264, SD 85) and predicted values (mean 255, SD 61). Finally, the average quality of life of individuals with cancer (mean 56.13, SD 23.38) showed a significant difference (p<0.001) when compared to the predicted value (mean 73.10, SD 25.16). The results are shown in Table 2.

Table 2. Difference in grip strength, functional capacity, and quality of life between the values found in individuals with cancer and predicted values in healthy individuals

	Individuals with cancer	Healthy Individual (Predicted)	Two-sample Kolmogorov-Smirnov test
Handgrip strength (Dynamometer - kgf)	25 (9)	29 (8)	p<0.001
Functional capacity (Glittre ADL - seconds)	264 (85)	255 (61)	p<0.01
Quality of life (SF-36 - 0-100 points)	56.13 (23.38)	73.10 (25.16)	p<0.001

SF-36: *Short Form Health Survey*.

Correlation and regression analysis between handgrip strength, functional capacity, and quality of life in individuals with cancer

A significant correlation of high magnitude between strength and functional capacity was found (ρ=-0.58; p<0.01), and moderate between strength and quality of life (ρ=0.46; p<0.01). Furthermore, a significant correlation of high magnitude between functional capacity and quality of life was also found (ρ=-0.51; p<0.01). The values of each correlation are found in Table 3. In the regression analysis, only functional capacity remained in the model (p<0.01) as a predictor of quality of life, being able, alone, to explain 20% (R²=0.195) of this variable.

Table 3. Spearman's correlation coefficient was used to analyze the correlations between handgrip strength, functional capacity, and quality of life.

	Handgrip strength	Functional capacity	Quality of life
Handgrip strength (Dynamometer - kgf)	-	ρ=-0.58 (p<0.01)	ρ=0.46 (p<0.01)
Functional capacity (Glittre ADL - seconds)	-	-	ρ=-0.51 (p<0.01)
Quality of life (SF-36 – 0-100)	-	-	-

SF-36: *Short Form Health Survey*.

DISCUSSION

This study aimed to evaluate the strength, functional capacity, and quality of life of individuals with cancer compared with predicted values in healthy individuals, in addition to investigating possible correlations between the variables and the best predictor for quality of life. The results showed a significant difference between all variables collected and their predicted values, indicating that individuals with cancer have lower strength, functional capacity, and quality of life than predicted values in healthy individuals. Similarly, there was a significant correlation between all variables, demonstrating that individuals with reduced handgrip strength presented decreased functional capacity and lower perception of quality of life. Finally, functional capacity can be considered a predictor of the quality of life of this population.

The mean strength found in the evaluated participants (25kg) was significantly lower when compared with the predicted values (29kg). Recent studies in the literature corroborate the results of this study, reporting a decrease in strength in the analyzed samples of individuals with cancer

compared to healthy individuals[15,17]. In fact, individuals with cancer undergo changes due to their own disease and the treatment for it[30]. These changes may also be combined with depression and loss of appetite, which initiate a vicious cycle, leading to loss of muscle mass and a drop in physical activities, which result in a global weakness[4]. A recent study with 51 individuals with cancer, although it found an average handgrip strength value similar to our study (23kg), did not identify a significant difference when compared to healthy individuals[31]. However, it is noteworthy that Silva et al.[31] used as control group older adults with different musculoskeletal conditions, which may have compromised their results.

This study also demonstrated a decrease in the functional capacity of individuals with cancer. These results were expected, since the reduction in functional capacity is associated with a greater dependence to perform daily activities[32]. This reduction occurs due to the possible alteration, by treatment and disease, of the cognitive, locomotor, and communication systems, which are fundamental for the execution of daily tasks[32]. The result of this study is similar to the findings of a previous study[13], which evaluated the functional capacity of 128 women, and reported a significant reduction in functional capacity in these patients. However, such data were not compared with healthy individuals or predicted values[13]. Another study also reported a significantly reduced functional capacity in individuals with cancer when compared to healthy individuals[17]. However, this study evaluated functional capacity by balance, gait speed, and quadriceps strength[17], measures that cannot be considered for evaluation of this construct.

Regarding quality of life, previous studies evaluated this domain in individuals with cancer and they reported, similar to our study, reduced values[33,34]. However, this conclusion was based only on the authors' interpretation, since the values found were not compared with those of healthy or predicted individuals. In fact, the ability to perform daily activities, satisfaction, and levels of functionality are essential to determine the quality of life in breast cancer survivors[33]. Persistent symptoms associated with adverse effects of treatment, such as pain and fatigue, can lead to reduced functional capacity, as previously demonstrated, directly affecting the perception of the quality of life of these individuals, who feel more dependent, depressed, and less satisfied with their current life condition[30].

Finally, this study identified a correlation between all evaluated variables. Thus, individuals with cancer who present a decrease in handgrip strength need more time to perform daily activities and, thus, have a worse perception of their quality of life. Similar results were found in previous studies, which also analyzed the correlation between these variables and found significant results between strength and quality of life[35], and functional capacity and quality of life[36]. Although it is suggestive that the muscular weakness of these individuals can cause a decrease in functional capacity and consequent worsening of quality of life, such interpretation deserves caution[37]. A correlation analysis has no potential to determine a cause-and-effect relationship, so we cannot affirm that one condition causes the other, but we can do indicate that they are related[27]. On the other hand, regression provides the coefficient of determination or explanation (R^2), which indicates how many percent the variation explained by the regression represents over the total variation[27]. In this study, although strength and functional capacity are correlated with quality of life, only the latter was able to predict the SF-36 score, indicating that, when changes occur in quality of life, 20% of this change can be explained by changes in the functional capacity of individuals with cancer.

The main positive point of this study is the conduction of a research, which fills significant gap in the literature, with the use of low cost instruments, easy handling, quick application, with properties of appropriate measures, and that can be used in work, school, and hospital environments. However, we can mention as the main limitation of the study the use of predicted values found in the literature, which may not be as sensitive as those directly collected from a sample of healthy individuals. Moreover, the reference value of functional capacity was based on an Indian study, since they do not have values published in Brazil, which may not be generalizable for our population.

CONCLUSION

The results of this study demonstrated that individuals with cancer present reduced strength and functional capacity, as well as significant worsening of quality of life, when compared to predicted values in healthy individuals. Furthermore, there is a correlation between all these variables, indicating that individuals with reduced handgrip strength have a decrease in functional capacity and a lower perception of quality of life, and 20% of the latter can be explained only by functional

capacity. These results are clinically relevant because they demonstrate the significance of strength and, especially, the functional capacity of these individuals, for better clinical decision-making, aiming at a better quality of life.

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