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Effects of a 12-week exercise intervention on glycated hemoglobin (HbA1c) levels in cancer patients
Efectos de una intervención de 12 semanas de ejercicio en los niveles de hemoglobina glicada (HbA1c) en pacientes con cáncer

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Abstract. Exercise has been associated with lower risk of cancer development and recurrence. Studies suggest that exercise is effective in reducing the risk of developing metabolic alterations. Due to the inconclusive results of previous studies, this research aims to evaluate the effects of a 12-week concurrent exercise programme on the reduction of glycated hemoglobin (HbA1c) levels in cancer patients. 22 non-diabetic patients were randomly assigned to a 12-week combined exercise intervention or to the control group. Baseline and 3-month assessments were performed to evaluate changes in HbA1c, fat and musculoskeletal mass for the 22 participants who completed the study. Analyzing the sample there were significant improvements in HbA1c ($p=0.033$), when excluding those over 65 years of age, the differences were greater ($p=0.017$). Although no significant differences were found between the reductions of subjects with different baseline HbA1c levels, those with higher levels reduced values by 6.8% and those with normal levels by 3.6%. Furthermore, no correlation was found between reductions in HbA1c and changes in body composition. This 12-week combined exercise intervention resulted in a reduction in HbA1c levels, but this change was not associated with changes in body composition.
Key Words: Oncology, Exercise, Body Composition, Concurrent Training, Glucose, Glycated Hemoglobin.

Resumen. La práctica de ejercicio físico ha sido asociada a un menor riesgo de desarrollo y recurrencia del cáncer. Asimismo, estudios previos sugieren que el ejercicio es eficaz para reducir el riesgo de desarrollar alteraciones metabólicas. Por lo tanto, esta investigación pretende evaluar los efectos de un programa de ejercicio combinado de 12 semanas sobre la reducción de los niveles de hemoglobina glicada (HbA1c) en pacientes con cáncer. Para ello, 22 pacientes no diabéticos fueron asignados aleatoriamente a una intervención de ejercicio combinado de 12 semanas o al grupo control. Se realizaron evaluaciones iniciales y a los 3 meses para valorar los cambios en los niveles de HbA1c, la grasa y la masa musculoesquelética de los 22 participantes que completaron el estudio. Analizando la muestra hubo mejoras significativas en los niveles de HbA1c ($p=0,033$). Además, cuando se excluyeron los mayores de 65 años, las diferencias fueron mayores ($p=0,017$). Aunque no se encontraron diferencias significativas entre las reducciones de los sujetos con diferentes niveles basales de HbA1c, los que tenían niveles más altos redujeron los valores en un 6,8% y los que tenían niveles normales en un 3,6%. Además, no se encontró ninguna correlación entre las reducciones de la HbA1c y los cambios en la composición corporal. Esta intervención de ejercicio combinado de 12 semanas dio lugar a una reducción de los niveles de HbA1c, pero este cambio no se asoció con los cambios en la composición corporal.
Palabras clave: Oncología, Ejercicio, Composición Corporal, Entrenamiento Concurrente, Glucosa, Hemoglobina Glicada.

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Introduction

Cancer is currently one of the leading causes of mortality in developed countries (WHO, 2022). Recently, the Global Cancer Observatory (GCO, 2020) published the future incidence and mortality from cancer, reporting a 20% increase in new cases and a 29% increase in the number of deaths in Europe by 2040. Furthermore, the highest incidence and mortality rates are focused on those over 65 years of age, due to the accumulation of risk factors which may be attenuated with exercise (Río et al., 2020).

Consequently, research has been carried out on strategies to reduce the risk of cancer. These studies suggest that exercise can be an effective strategy to reduce the incidence of some types of cancer (Cigarroa et al., 2022; Gómez Chávez et al., 2022; Matthews et al., 2019). However, exercise not only reduces risk, but also provides physiological and psychological benefits for people with the disease (Dieli-Conwright et al., 2018a). In addition, it also reduces the risk of metabolic disturbances and comorbidities associated with cancer treatments (Kang et al., 2018), in addition to reducing oncological fatigue (Bezerra et al., 2022).

Therefore, exercise acquires an important therapeutic relevance. Due to the different types of cancers and the diversity of the affected population, it is difficult to establish general recommendations. However, the American College of Sports Medicine (ACSM) (2018) provides guidance regarding these. Thereby, a minimum of 150 min/wk of moderate to vigorous physical activity and a minimum of two sessions of strength training should be included. However, despite guidelines from multiple international agencies, exercise prescription is not considered the standard of care for people at risk or with cancer (Iyengar & Jones, 2019).

However, the effects of exercise on some health markers remain unknown. Considering that metabolism and cancer are diseases that have several similarities, such as chronic inflammation and hyperglycaemia, it is of particular relevance to investigate the impact of exercise on different biochemical markers (De Beer & Liebenberg, 2014). Although the biological mechanisms involved are not entirely clear, high glucose levels have been associated with a higher incidence and worse prognosis of the disease (Barua et al., 2018; De Beer & Liebenberg, 2014). Exercise decreases insulin levels and insulin resistance and improves glycaemic control in cancer patients, decreasing metabolic disturbances (Christensen et al., 2019; Kang et al., 2020; Wang et al., 2020).

In metabolic regulation, adipose tissue and skeletal muscle are two important endocrine organs. Each of them secretes different hormones that can help in the control of blood glucose. On one hand, muscle expresses cytokines such as interleukin-6, which increases glucose uptake and fat oxidation. On the other hand, adipose tissue secretes hormones that are also involved in glucose metabolism, for example adiponectin, which increases insulin sensitivity (McArdle et al., 2015; Rodwell et al., 2016). In this way, the scientific literature suggests that body composition could be a relevant aspect of glycaemic control. This is because increasing musculoskeletal mass and reducing body fat could be responsible for the improvements in glycaemic control (Cavero-Redondo et al., 2018; Guinan et al., 2013; Sénéchal et al., 2013).

Therefore, HbA1c testing is becoming more common, as it is a biomarker that provides a retrospective view of blood glucose over the two-three months prior to measurement. Furthermore, HbA1c levels are proportional to blood glucose concentration (McArdle et al., 2015; Rodwell et al., 2016). Regarding the HbA1c values, using the National Glycohaemoglobin Standardisation Programme (NGSP) reference, HbA1c values above 6.5% are consistent with a diagnosis of diabetes. Individuals whose HbA1c levels are between 5.7% and 6.4% are at the prediabetic level and the non-diabetic level includes values between 4% and 5.7% (American Diabetes Association, ADA, 2013). It is important to mention that adherence to exercise recommendations for cancer patients has been associated with lower HbA1c levels. However, the studies carried out on the effects of exercise on this parameter in cancer patients are inconclusive (Bourke et al., 2018; Christensen et al., 2019; Dieli-Conwright et al., 2018b; Guinan et al., 2013; Schmidt et al., 2017).

Consequently, we hypothesize that a 12-week exercise programme is effective to reduce HbA1c levels in cancer patients. This study aims to evaluate if greater reductions in HbA1c are achieved when baseline levels are higher (over 5.7%) and to assess any relationship between improvement in body composition and HbA1c reduction.

Materials and methods

Study design

This study corresponds to the research project called "Bizi Orain" (BO) which has not yet been concluded. BO is a hybrid exercise programme aimed for cancer patients and is based on the guidelines of the "Life Now" exercise programme in Australia (Arietaleanizbeaskoa et al., 2020). This study is carried out in the first phase of the programme, which has a duration of 3 months. In this first phase, patients are randomly divided into two parallel groups following a 1:1 system. The exercise group participates directly in the BO intervention. The control group, on the contrary, follows the guidelines of a pre-established behavioral intervention called "Prescribe Vida Saludable" (PVS) (Sanchez et al., 2009). Thus, all participants are evaluated at the beginning (zero months) and at the end (three months) of the intervention.

Participants

The inclusion and exclusion criteria used were similar to those of the BO programme. Anyone diagnosed with cancer during the previous two years was referred to the study. In order to ensure the safety of patients, participants were excluded if they met any of the following criteria: neutropenia, severe anemia, bone metastases or other comorbidities that made exercise impossible (Arietaleanizbeaskoa et al., 2020). In addition, patients diagnosed with diabetes were also excluded from the study, because having blood glucose levels under control would have made it difficult to analyze BO-induced changes in HbA1c levels. As in the BO research project, participants were recruited through the different services of the Basque Country health system. Therefore, patients were referred to the programme by healthcare professionals. Recruitment took place from November 2020 to February 2021. Those patients who participated in the programme had to sign an informed consent form in order to be referred for the initial evaluations of the programme (Arietaleanizbeaskoa et al., 2020). The study was approved by the Basque Research Ethics Committee on Medicines (CEIm-E, PI2019016).

Intervention

The 12-week aerobic and strength exercise intervention was as described in the BO protocol (Arietaleanizbeaskoa et al., 2020). On a weekly basis, subjects perform two supervised sessions of 1h-1h15' in small groups (~eight people) and a third one independently walking around the center at an established intensity. The first part of the session will be aimed to perform multi-joint exercises, progressing from static exercises to more dynamic ones that require a higher demand. In addition, 2-3 sets of 9-12 repetitions at an intensity of 60% of one repetition maximum (1RM) will be performed at the beginning and will end with four sets of 7-10 repetitions at 70% of 1RM. In the last 30 minutes the subjects will perform aerobic exercise using cycle ergometers and treadmills. The intensity will increase throughout the sessions. The intensity zones will be monitored by maximum heart rate (applying specific intensity limits based on heart rate reserve) combined with the modified Borg scale (0-10) (Arietaleanizbeaskoa et al., 2020).

Measurement Protocol

In this study, participants were evaluated twice, before starting the intervention and after 3 months (post-intervention). In these evaluations, participants underwent the measurements described in the BO program protocol,

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including HbA1c analysis and body composition assessment (Arietaleanizbeaskoa et al., 2020). HbA1c measurement required a small capillary blood sample. Participants did not have to follow any specific instructions, as it is not necessary to perform the test on an empty stomach (Biolaster, 2022). Body composition assessment was performed using the InBody 770 analyzer and participants followed the protocol previously described in the validation study by Ling et al. (2011).

Measuring Instruments

InBody 770 Body Composition Analyzer

Body composition was analyzed by direct segmental multifrequency bioimpedance, concretely using the InBody 770 analyzer. This analyzer is a reliable tool to assess body composition, as the reliability level is 98% compared to the results obtained with DEXA (InBody, 2014; Ling et al., 2011). Although the InBody provides information about multiple parameters, in this study only skeletal muscle mass and body fat mass will be discussed, given that they are the more relevant variables for the research.

Quo-Lab HbA1c Analyzer

HbA1c levels refer to the average blood glucose over the last three months. This parameter was measured using the EFK Diagnostics Quo-Lab HbA1c analyzer, which requires four microliters of blood. This instrument is homologated by the NGSP, an international organism specialized in the standardization of HbA1c measurement results. Moreover, in 2016 the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) certified that the coefficient of variation of the Quo-Test analyzer (instrument with the same analysis procedure and precision as Quo-Lab) was 0.88% and the correlation coefficient 0.998 with respect to other methods (Biolaster, 2014).

Statistical Analysis

The variables analyzed in this study are presented as mean and standard deviation. IBM SPSS Statistics Software (version 28) was used for their analysis. After observing the normality of the variables as well as the study groups, parametric tests were performed. Student's t-test for paired samples was used to determine whether there were improvements between pre-intervention and post-intervention data in relation to the HbA1c variable. One-factor ANOVA (three groups by HbA1c levels) was used to determine differences between groups. In addition, Pearson correlations were used for the relational analysis of body composition and HbA1c level. The significance level for all statistical analyses was established at 0.05 ($p \leq 0.05$).

Results

Thirty participants were selected from those in the BO programme who met the eligibility criteria and gave their consent for the present study. Although the study started with 30 subjects, baseline characteristics were obtained from 29 subjects. These were randomly assigned to the exercise group (EG) or control group (CG). After the intervention, only 22 subjects completed the two evaluations in which the study consisted (76,6% retention) (Figure 1). The exercise intervention controlled by primary care nurses and exercise professionals was safe and no adverse events were reported. In addition, subjects in the exercise group had a high adherence rate, attending more than 80% of the sessions.

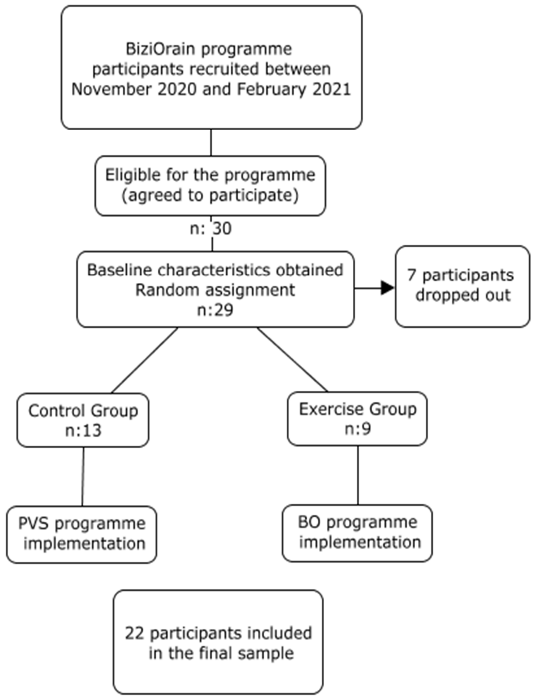

Figure 1. Participant´s recruitment flow diagram

Baseline characteristics are shown in Table 1. Among participants, solid tumors were predominant (90.9%), of which breast cancer was the most common (45.45%). 81.8% of the individuals were women who were mainly diagnosed with breast cancer (55.6%) and were mostly treated with chemotherapy alone (70%). Regarding body mass index (BMI), before taking part in the intervention 55.5% of the subjects in the exercise group were overweight and 22.2% obese. In the control group, on the other hand, 38.4% of the participants were overweight and 38.4% obese (WHO, 2022). Although differences between the control and exercise groups were observed at baseline for age, fat and BMI, these differences were not significant.

The proposed hypothesis was that a 12-week exercise programme is effective in reducing HbA1c levels in cancer patients. To examine the effects of the exercise intervention on HbA1c levels, normality tests and subsequently a student’s t-test were performed. As already mentioned, the normality hypothesis is accepted for the statistical analysis of the differences in HbA1c levels in each group separately, those who perform the exercise intervention

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and those who do not. If the total sample is analyzed without excluding those over 65 years of age, the differences are significant (P=0.033). Furthermore, when Student's t-test was performed excluding those over 65 years of age, a more significant reduction in HbA1c concentration post-intervention was observed in the exercise group (P=0.017) (Table 2). In contrast, in the control group the values remained the same.

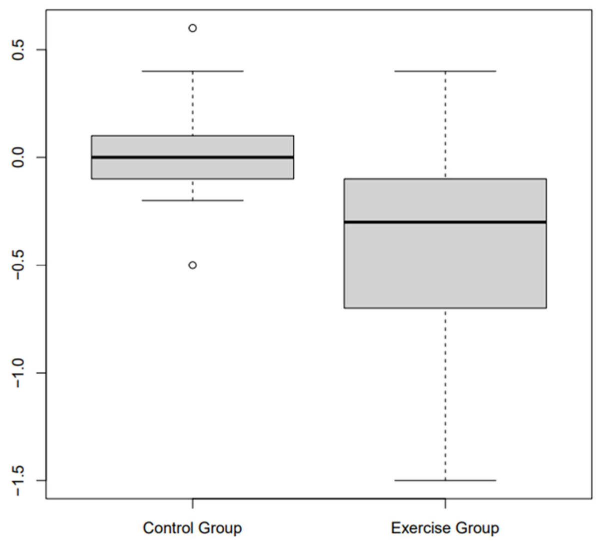
Table 2.
Mean difference HbA1c all and under 65

Group	Mean difference HbA1c	Control Group	Exercise Group	P value
All	-0.416	+0.038	-0.377	0.033
n=22		n=13	n=9	
Under 65	-0.522	+0.072	-0.450	0.017
n=19		n=11	n=8	

Table 1.
Characteristics of the participants

n	Basal	0M	3M	EG0M	EG3M	CG0M	CG3M
All	29	22	22	9	9	13	13
Men	6	4	4	2	2	2	2
Women	23	18	18	7	7	11	11
Over 65	3	3	3	1	1	2	2
Mean (SD)	Basal	0M	3M	EG0M	EG3M	CG0M	CG3M
Age (years)	53.91 (11.05)	56.1 (10.59)	56.1 (10.59)	51.92 (13.36)	51.92 (13.36)	58.99 (7.42)	58.99 (7.42)
BMI (kg/m²)	27.44 (5.50)	27.2 (5.84)	27.25 (6.10)	24.61 (3.06)	23.76 (3.02)	28.99 (6.70)	29.12 (6.60)
HbA1c (%)	5.88 (0.45)	5.9 (0.48)	5.77 (0.55)	6.01 (0.53)	5.63 (0.64)	5.83 (0.46)	5.87 (0.48)
IFCC (mmol/mol)	40.7 (4.87)	41.05 (5.28)	40.11 (5.05)	42.11 (5.70)	39.51 (4.66)	40.31 (5.07)	40.52 (5.45)
Fat mass (kg)	26.3 (11.19)	26.11 (11.70)	26.11 (12.18)	21.41 (6.38)	20.14 (6.71)	29.36 (13.58)	29.32 (13.43)
Muscle mass (kg)	25.86 (4.62)	24.87 (4.26)	24.91 (4.63)	24.37 (4.19)	24.86 (5.26)	25.22 (4.44)	24.95 (4.48)

Note. GE (exercise group); CG (control group); SD (standard deviation).



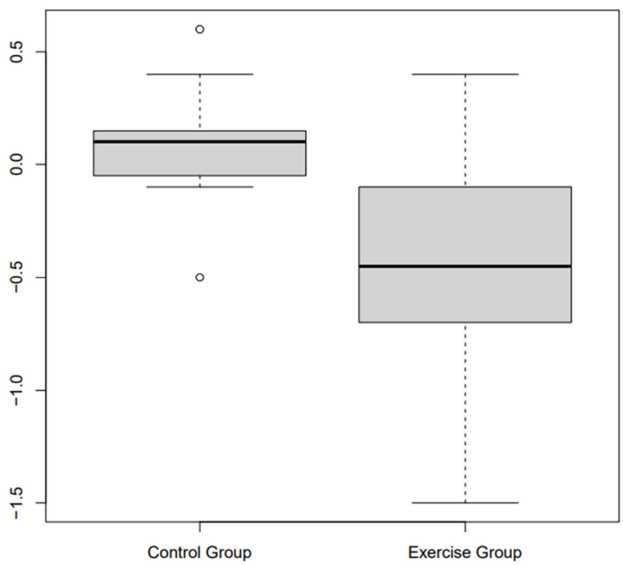


Figure 2. Note: 4A(left): Differences in HbA1c after intervention all; 4B (right): Differences in HbA1c after intervention excluding those over 65 years of age

In order to assess whether there are differences between groups according to their baseline levels, subjects were divided into three groups according to their baseline HbA1c values: HbA1c levels compatible with diabetic status (values above 6.5%), HbA1c levels compatible with pre-diabetic status (values between 5.7% and 6.4%) and levels considered normal (values between 4% and 5.7%) (ADA, 2013).

Considering the subjects of both groups, it was found that before participating in the programme 68.2% of the participants had HbA1c values above normal values, with 80% of them being compatible with pre-diabetic levels.

Dividing the participants into three groups and differentiating between exercise and control group leaves a very small sample. This analysis is not ideal as there is little information to represent the participants with normal HbA1c levels in the control group (two individuals). The same is applicable to the two groups with values compatible with diabetic levels, both in the exercise group (two individuals) and the control group (one individual). Although the reductions in the groups are not significant, as shown in Figure 3, the effects are in line with expectations.

The first graph (Figure 3) shows the three groups of participants divided by their corresponding HbA1c levels. Those subjects who have undergone the intervention are placed on the right side of the chart and those in the control group are placed on the left side. In addition, the horizontal black line acts as a guide to facilitate the visualization of whether or not have been any changes and how these have occurred. On the one hand, when examining individuals with normal values (red triangle), an increase

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of more than 0.2 is observed in individuals who do not take the intervention and a decrease of around 0.2 in those who take the intervention. On the other hand, regarding subjects with values compatible with the pre-diabetic level (represented by a blue circle), both groups tend to reduce their levels. In individuals not taking part in the intervention, HbA1c values decrease by 0.1. However, those who take part in the intervention obtain a larger decrease in values, specifically 0.32. Finally, participants with values compatible with diabetic levels (green square) show different trends depending on the group they belong to. Thus, participants in the control group maintain high levels. The subjects in the control group, however, have a decrease in their HbA1c values of 0.7%.

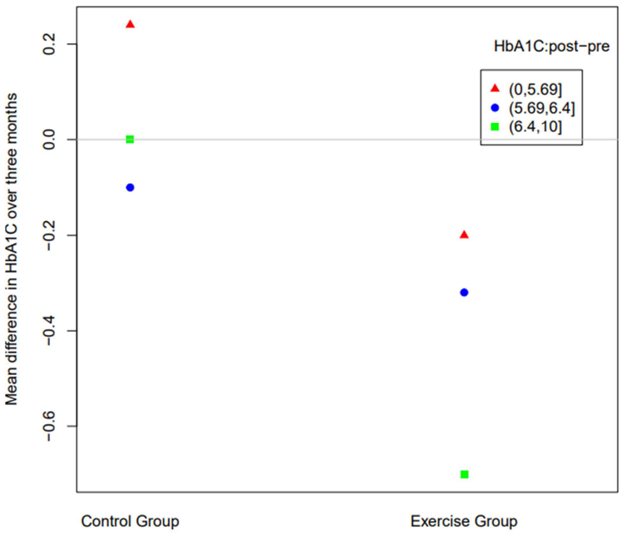

Figure 3. Differences in HbA1c with the sample divided into three groups

In order to visualize the changes in HbA1c values, table 3 summarizes the difference between the post and pre-mean values when performing or not the physical exercise intervention.

Table 3.
HbA1c mean difference according to baseline levels (3 groups)

HbA1c Values	N CG	N EG	Mean dif CG	Mean dif EG	Dif% CG	Dif% EG
HbA1C<5.7	5	2	0.24	-0.2	4.3%	-3.6%
5.7≤HbA1C≤6.4	7	5	-0.1	-0.32	-1.7%	-5.5%
HbA1C>6.4	1	2	0	-0.7	0%	-10.2%

Note. NGC (n control group); NEG (n exercise group); Mean Dif CG (mean difference control group), Mean Dif EG (mean difference exercise group).

Finally, Pearson's correlation analysis shows that there are no significant correlations between the variables (HbA1c, musculoskeletal kg and fat kg) in both the control and exercise groups.

Discussion

The results of this study demonstrate that a supervised 12-week exercise intervention led to significant reductions in HbA1c levels in cancer patients. Furthermore, when only subjects under 65 years of age were analyzed, the changes in HbA1c were even more significant. It is important to note that these improvements occurred without adverse events, thus supporting results of previous studies which indicated that exercise interventions aimed at cancer patients are generally safe (Singh et al., 2020).

At baseline, 68.2% of patients had HbA1c values that were compatible with the prediabetic or diabetic level. High blood glucose levels have been related to lower survival in oncology patients (Barua et al., 2018; Hope et al., 2016). Consequently, the findings of this research could be of vital importance in reducing mortality in cancer patients.

When all participants were included in the statistical analysis, HbA1c reductions were significant (p=0.033). These results are in line with previous research. As an example, Schmidt et al. (2017) reported significant reductions following a 24-week walking training program. Dieli-Conwright et al. (2018b) also observed significant improvements in the HbA1c values of 21 breast cancer patients who took part in a 16-week intervention. The exercise program had several similarities with respect to the BO program, given that aerobic and strength exercises were combined 3 times per week.

However, there are other studies which failed to find significant differences in HbA1c values. Guinan et al. (2013) reported no significant change in HbA1c values after 8 weeks of aerobic intervention (p=0.07). Moreover, studies that have conducted aerobic interventions of longer duration in cancer patients have also failed to find significant differences in HbA1c levels (Bourke et al., 2018; Christensen et al., 2019).

One of the reasons that could explain the significant reductions in HbA1c values could be that the training sessions were supervised. Thus, interventions that were not fully supervised failed to find significant differences (Bourke et al., 2018; Christensen et al., 2019; Guinan et al., 2013), while studies that were totally supervised did show significant reductions (Dieli-Conwright et al., 2018b; Schmidt et al., 2017). Two previous meta-analyses reviewed studies in healthy subjects and concluded that supervision of the training sessions seems to be a key factor in the effectiveness of interventions aimed at reducing the HbA1c levels (Boniol et al., 2017; Cavero-Redondo et al., 2018).

Another reason that could partially explain the different results obtained would be the mode of training, as most of the studies that did not find significant differences only included aerobic exercises (Christensen et al., 2019; Guinan et al., 2013; Bourke et al., 2018). However, both in this and Dieli-Conwright et al. author's (2018b) study, the participants also performed strength training, which is presumably a key factor in improving glycemic control (Raun et al., 2022).

A relatively unexpected finding was that when people over 65 years of age were excluded from the statistical analysis, the reductions became more significant. Thus, this leads one to suggest that changes in HbA1c are to some extent age-dependent. In this way, Masuch et al. (2021) demonstrated that HbA1c levels increase over the years independently of changes in blood glucose. This would explain why no significant changes were found when the entire group was analyzed. It is possible that those over 65 years of age in the exercise group maintained their HbA1c levels despite lowering their blood glucose levels.

Nevertheless, age is not the only factor that can influence HbA1c values. Reductions in HbA1c levels are usually greater when participants have type 2 diabetes or prediabetes (Boniol et al., 2017). The underlying explanation seems to be clear: diabetic patients have a greater range of improvement. In the present study, no significant differences were found when comparing subjects according to their HbA1c levels. However, it should be pointed out that the subjects in the exercise group with HbA1c values higher than 5.7% reduced their baseline values almost twice as much as those with values considered normal.

Apart from basal levels, some studies have suggested that exercise-induced changes in biomarkers are dependent on changes in body composition. In the study by Sénéchal et al. (2013) participants with type 2 diabetes participated in a nine-month exercise intervention. Changes in HbA1c were associated with changes in trunk fat mass. Thus, the authors suggest that reducing central adiposity is an important factor to improve glycemic control and reduce HbA1c levels.

Some of the studies that have analyzed these parameters in cancer patients found improvements in both variables, including Dieli-Conwright et al. (2018), who observed an increase in lean mass and a decrease in fat mass (approximately 4 kg) in the exercise group, whereas the control group suffered an increase in body fat percentage. This is consistent with the study by Schmidt et al. (2017), in which the researchers observed significant reductions in HbA1c and body mass index.

However, Christensen et al. (2019) did not report significant changes in HbA1c values, although an increase in total fat mass, especially android fat, was observed in the control group. This increase resulted in a significant difference between groups. Consequently, the authors propose that the early adaptive response to exercise is mediated by the improvement of peripheral insulin sensitivity.

Neverless, there are studies that found no significant differences in any of the variables. As an example, Guinan et al. (2013) reported no significant differences in HbA1c and body composition after an eight-week intervention in people with breast cancer. Consequently, the authors indicate that it is unclear whether exercise can improve metabolic parameters without a loss of body fat.

The results of this study may provide further insight into that question, as significant differences in HbA1c levels were observed without changes in body composition. Thus, the results indicate that exercise-induced changes in HbA1c are not entirely dependent on changes in body composition.

Consequently, changes in HbA1c could be induced by mechanisms related to muscle quality. According to McArdle et al. (2015), improved muscle quality leads to an increase in capillary density and this enhances the delivery of glucose to the muscle. Likewise, Sjøberg et al. (2017) demonstrated that exercise increases insulin sensitivity in skeletal muscle through increases in microvascular perfusion and molecular signaling. Christensen et al. (2019) concluded that one of the most rapid adaptive responses to exercise is improved peripheral insulin sensitivity. This makes fewer glucose molecules available in blood. Consequently, the binding of glucose to hemoglobin heteroprotein decreases, resulting in a decrease in HbA1c (Cavero-Redondo et al., 2018). Therefore, this could be the reason why significant differences in HbA1c levels but not in body composition were found in this study. In addition, one of the reasons why the differences in body composition were not significant could be the duration of the intervention. Reductions in body percentage are usually greater when interventions last longer than 12 weeks (Singh et al., 2020). Therefore, it is possible that the duration of this intervention was not long enough to reduce fat mass.

This study has some limitations. Firstly, the sample was small and diverse so it was not possible to segregate by sex. Secondly, the duration of the intervention may not have been long enough to induce significant changes. In addition, the presence of corticosteroid-based treatments has not been collected, that could have increased glucose levels, masking the effects of the established intervention. Moreover, there was no registration of the exercise performed by the control group. It is possible that the subjects in the control group started to change their initial lifestyle to healthier behaviors in response to the advice of the PVS program. Furthermore, the eating habits of the patients were also uncollected.

However, several strengths can be highlighted, including the randomized controlled trial design. Moreover, the measuring instruments are highly reliable. Another strength would be the high rate of adherence (more than 80%) among the participants. Finally, this is the first study to our knowledge to observe differences in HbA1c but not in body composition in patients with cancer. This finding may be highly relevant for understanding the physiological mechanisms involved in glycemic control.

Future research should confirm these initial findings by including a larger sample. It would also be interesting to evaluate the efficacy of different types of intervention, for instance strength and aerobic training. This would provide more specific guidelines for exercise professionals in the design and execution of programs aimed at people with cancer. Although the short-term results are encouraging, longer-term studies with periodic evaluations are needed to examine not only the long-term effects, but also the relationship between HbA1c and body composition.

The 12-week concurrent training intervention resulted in a reduction in HbA1c levels, however this change was not associated with changes in body composition. Future studies with longer duration and a larger sample size are warranted to investigate the impact of exercise-induced reductions in HbA1c values and anthropometric parameters.

Conclusions

This study demonstrates that a physical exercise intervention can help reduce HbA1c levels in cancer patients. Furthermore, we believe that it is one of the first studies to report changes in HbA1c levels without finding significant changes in body composition. This fact could be of particular relevance to investigate the mechanisms by which exercise induces changes in HbA1c values. In summary, the results are promising and consequently, further studies on the effects of physical exercise in cancer patients are essential.

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