

Development and Implementation of New Online Strategies That Increase Physical Activity Behaviour in Cancer Patients

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1. Abstract

1.1. Purpose: The purpose of this study was to evaluate effectiveness of different online exercise strategies to increase physical activity levels in cancer patients implemented during the lockdown that may be maintained as usual care after it.

1.2. Methods: Three different strategies were designed and implemented during the lockdown, adapting the exercise oncology service in two ways: based on restrictions of the pandemic situation and the evolution of pandemic information.

1.3. Results: After exercises interventions, cancer patients reported a significant rise of 92% in physical activity levels and a reduction of 52.9% in sitting time. In terms on the weight, there were no significant changes.

1.4. Conclusion: Online programs were an effective strategy to increase physical activity levels in cancer patients during the lockdown, particularly when the partial lockdown was in effect. A higher level of control and longer intervention were more effective in increasing physical activity levels in cancer patients during and after the lockdown.

2. Introduction

In 2020, the global COVID-19 pandemic forced the entire Western population into a lockdown for nearly three months. In Spain, this time consisted on a total lockdown [TL] for 45 days, followed by a

partial lockdown [PL] for an additional 54 days [outdoor physical activity was allowed in some time slots]. As a result of this lockdown, the time spent in moderate-intensity activities decreased steeply [approximately 33%], while sedentary time increased by approximately 29% [1]. Moreover, the times of the total and partial lockdowns decreased depending on the pandemic's evolution, which created a sense of uncertainty that lasted throughout the lockdown [1–3].

During the pandemic, all medical and social services were altered [4,5] and telehealth assistance was implemented [1] especially for patients with chronic pathologies such as cancer. In this case, cancer patients may have been immunosuppressed because of cancer treatments and disease, having a greater risk for severe COVID-19 if they were infected. Specifically, in the largest cities, health services were overwhelmed, and hospitals and health centers were places where patients were at risk of meeting infected people. As a result, during lockdown, there was a reduction in activities devoted to cancer patients, including diagnosis, surgical and medical treatments, and rehabilitation [1,6,7].

Sedentarism linked with some cancer treatment side effects leads to significant reductions in fitness capacity and muscle mass and increased levels of obesity, which may impact patients' quality of life and functionality [8]. In this sense, physical activity is an effective tool to prevent muscle mass loss and improve fitness capac-

ity in these patients [9–11], which becomes an essential strategy for both reducing high sedentarism levels during cancer treatments and preventing some important side effects caused by systemic and local therapies [9,12,13].

As occurred with other health services [1,4,5] in the Spanish Cancer Association of Madrid [AECC-Madrid], during the pandemic lockdown, all services that were offered to cancer patients, including exercise interventions, had to be transformed into online programs; during the process, we tried to learn the best strategy to achieve our goals. Three different interventions that were adapted during the lockdown were set up to raise physical activity levels to reduce cancer treatment side effects, especially physical dysfunction, and fatigue. Furthermore, our primary objective was to evaluate the impact on physical activity levels and in sedentarism behavior during the lockdown in cancer patients. As a secondary objective, in accordance with our experience, we want to determine what type of program was more effective in increasing physical activity levels and achieving better levels of adherence to physical activity three months after the intervention, with the intention to include it as online usual care in exercise oncology strategies.

3. Methods

From 13 March to 21 June 2020, all cancer patients were assisted by a specialist nurse who detected cancer patients' necessities and health status using an online videoconference or phone from the AECC-Madrid. Individuals with cancer were eligible to participate in one of the three online strategies if they were: [1] 18 years or older, [2] diagnosed with any type of cancer, [3] had an Eastern Cooperative Oncology Group [ECOG] ≤1, [4] able to walk 500 meters without resting, [5] presented with any physical side effect related to cancer treatments such as weakness, fatigue, changes in body composition, and/or pain, [6] did not present with a physical or psychological disability that could impact exercise testing or

training, [7] had an ejection fraction above 50% and [8] did not present untreated bone metastasis.

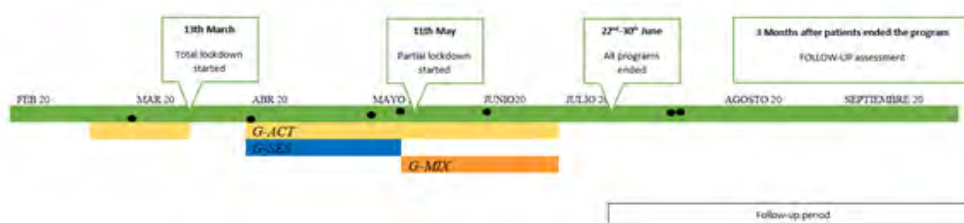
Considering the stage of the illness, the participants were divided into three different groups of patients:

- a) Patients who had recently finished their treatments but still presented secondary effects such as fatigue, changes in weight of more than 5 kg or general arthralgias [patients under hormonotherapy were included here].
- b) Patients undergoing chemotherapy, radiotherapy, or targeted therapy treatments.
- c) Patients with advanced or metastatic cancer.

4. Interventions

Three different strategies were designed and implemented during the lockdown, adapting the exercise oncology service in two ways: based on restrictions of the pandemic situation and the evolution of pandemic information. All these interventions were designed, supervised, and developed by an exercise-oncology specialist and adapted to every patient's characteristic. Depending on the stage of the lockdown, the patients were assigned to one of the three strategies.

All the classes implemented in every intervention had the same structure: 15 minutes of warm-up including articular mobility, slight walking, and other functional movements, starting at 50% of the heart rate reserve [HRR] and gradually increasing cardiovascular intensity. After that, 20 minutes of cardiovascular exercises from 60% to 80% of the HRR were performed, followed by 20 minutes of strength exercises, including self-loading or low-load exercises [1-5 kg]. Classes ended with 5 minutes of full body stretching. (Figure 1) presents a graphic description of these programs.



PROGRAM	Total sessions/times per week/Duration	Nº Groups	Cardiovascular intensity	Strength intensity	Outcome and settings
G-ACT	24 sessions /2 d/w /12 weeks.	6 groups	From 70 to 80% HRR	Self-loads exercises And 1 to 5kg	- Demographic and Clinical data - Physical level baseline (Fitness capacity, maximal strength, and BC, 6MWT and squats) - Weight baseline and follow-up - Physical Activity level.
G-SES	2 sessions + PC / 1d/w / 2 weeks	5 groups	70% HRR	Self-loads and 1kg	- Demographic and Clinical data - Weight baseline and follow-up - Physical Activity Level

	G- MIX	6 sessions + PC / 2d/w / 3 weeks	4 groups	From 70 to 80% HRR	Self-loads and 1-2kg	<ul style="list-style-type: none"> - Demographic and Clinical data - Weight baseline and follow-up - Physical Activity Level - 6MWT baseline and final - Squats baseline and final - Fatigue
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PC= personal counselling; BC= body composition; 6MWT= 6 minutes walking test.

Figure 1: Programs schedule and characteristics.

4.1. Activity group: G-ACT

Objective: The main objective of this program was to increase physical activity levels and improve the physical condition for 12 weeks after total lockdown started. This program had already started in February 2020 as a site program, and it was adapted to an online version and restarted on 1 April.

Program Description: After an onsite physical assessment, an online supervised program was developed, consisting of 24 group classes, 2 times per week [t/w], for 60 min. The intervention consisted of a progressive, supervised, and multi-component exercise program. A final one-to-one session was developed to provide personal counseling about exercise for each patient.

Schedule: from 1 April to 22 June 2020

Duration: 12 weeks.

Participant characteristics: Only patients who had an on-site baseline assessment before the lockdown were included in the program to ensure patient safety. No other patients were admitted.

4.2. Two sessions group: G-SES

Objective: The main aim of this strategy was to personalize every patient’s physical activity to ensure their safety while performing physical exercise at home, motivating patients to increase their physical activity levels during the total lockdown.

Program Description: A one-to-one initial interview with personalized counseling was provided, followed by two online group exercise classes focused on giving examples about how to do exercise at home. Exercise classes were developed in small groups [6 to 8 patients]. Group classes consisted on one class of combined workouts and another class describing stretching and isometric exercise. A final one-to-one session was developed to provide personal counseling about exercise for each patient.

Schedule: From 30 March to 20 May 2020. This strategy was the first to be implemented after the total lockdown was declared.

Duration: 2 weeks.

Participant characteristics: Cancer patients who had contact with the AECC Madrid who fulfilled the inclusion criteria. This program was performed with patients during the total lockdown.

4.3. Mixed group: G-MIX

Objective: The main objective of this strategy was to provide concrete guidelines about the type of exercise that each patient could develop by themselves at home and outdoor.

Program Description: A one-to-one online interview with personal counseling followed by six exercise online classes, 2 times/ week. This program consisted on two classes of cardiovascular exercise, two classes of strength exercises, one class of combined workout, and one class of stretching. A final one-to-one session was developed to provide personal counseling about exercise for each patient.

Schedule: From 11 May to 30 June 2020. This strategy was implemented during the partial lockdown and focused on indoor and outdoor exercise, considering that outdoor exercise was allowed in different bouts of time.

Duration: 3 weeks.

Participant characteristics: Cancer patients who contacted the AECC-Madrid from 11 May 2020 to the end of the lockdown and fulfilled the inclusion criteria.

All these strategies were complemented with one extra weekly online class, supporting material with cancer-specific workouts, and final personalized counseling to maintain the physical activity level. Patients in the G-ACT intervention had already attended on-site classes. Related to the G-SES and G-MIX interventions, patients were included depending on the lockdown situation.

Follow up

All patients were recontacted in September to evaluate exercise levels after these different strategies of exercise promotion and counseling.

5. Outcomes and Settings

5.1. Descriptive Variables

Clinical and demographic data were collected by a questionnaire in the first one-to-one interview. In this interview, each patient was asked about their hospital of reference, sex, birth date, height, tumor type, treatments received, and cancer status [currently under treatment, after treatments, or metastatic disease].

5.2. Outcome Variables

The level of attendance was collected in each session for every program. The rest of the variables were assessed in relation to the four specific stages:

- a) PRE=pre-lockdown,
- b) LOCKDOWN=post-lockdown and preintervention,
- c) INTERVENTION= after intervention and
- d) FOLLOW-UP= 3 months after the end of the intervention.

5.3. Main Outcome

Physical activity level was the main outcome, and it was assessed using the IPAQ questionnaire [14], considering both the level of physical activity [measured by the metabolic equivalent task [MET], which is the energy consumed in a resting condition] and sitting time per day [hours/day].

5.4. Other Outcomes

Anthropometrics: Patients self-reported their weight following the same instructions to homogenize the data: fasting weight at wake-up time, weight without clothes, and weight after urinating.

Related to the G-ACT intervention, different physical assessments were developed at baseline:

Body composition was assessed by bioimpedance using an Inbody 770, [Microcaya, 2016 S.L]

Fitness capacity was assessed by the cardiovascular physical exercise test [ml/kg/min]. Oxygen volume was registered by a gas analyzer [FitMate MED; Tecnomed 2000, S.L] [15]

Maximal strength was assessed by the test of 5 repetition maximum [RM] using the chest press and leg press performed on Technogym machines [Via Calcinaro, 2861, 47521 CESENA [FC].

Final assessments were not performed because the partial lockdown was maintained at the end of the program and indoor activities were not allowed.

Related to the G-MIX intervention, other outcomes were also assessed at baseline, at the end of the intervention, and at follow-up:

Fatigue level assessed by a self-administered Fact-F questionnaire [16]

Level of physical activity in leisure time was assessed by the self-administered Leisure Time Physical Activity Questionnaire of GODIN. [17]

6. Statistical Analysis

The demographic data and patient characteristics are presented using percentages or descriptive statistics [mean±SD].

Changes in physical activity levels by type of program were assessed using the MANCOVA test. Multiple regression models were fitted to evaluate the effect of each program at different stages of assessment, adjusting for sex, age, cancer type, and cancer treatment. All analyses were performed using SPSS v.20.0. IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.

7. Results

A total of 122 patients were treated during the COVID pandemic at the exercise oncology unit: 64 patients participated in the G-ACT intervention, 28 patients participated in the G-SES intervention and 30 patients participated in the G-MIX intervention. Ninety percent of the patients were women, and breast cancer was the most common type of cancer. Almost 50% of the included patients were receiving treatment, while only 18% had metastatic cancer. The demographic and descriptive data are shown in (Table 1).

Table 1: Baseline Characteristics of Cancer Patients Participating in novel strategies during COVID-19 pandemic.

	Total	G-ACT	G-SES	G-MIX
N, n (%)	121	63(52)	28(23)	30 (24.6)
Gender, n (%)				
M	11(9.1)	6(9.5)	4(14.3)	1 (3.33)
F	110(90.9)	57(90.5)	24(85.7)	29 (96.7)
Age, M±SD	50.8 ± 9.6	52.6 ± 8.1	48.9±11.3	63.9±10.1
Feasibility				
% assistance*	87	88	93	80
% adherence**	93	92	96	91
Type of Cancer, n (%)				
Breast	75 (61.9)	36 (57.1)	22(78.6)	17(56.7)
Colorectal	12(9.9)	7 (11.1)	1(3.6)	4(13.3)
Lung	8(6.6)	6 (9.5)	1(3.6)	1(3.3)
Ovary	9(7.4)	7 (11.1)	2(7.1)	0(0.0)
Lymphoma Non Hodgkin	4(3.3)	2 (3.2)	1 (3.6)	1(3.3)
Leukaemia	1(0.8)	0 (0.0)	0(0.0)	1 (3.3)
Pancreas	2(1.7)	1 (1.6)	0(0.0)	1 (3.3)
Other	10 (8.3)	4(6.4)	1 (3.6)	5(16.7)
Type of patients, n (%)				
Post treatment	40 (33.1)	24 (38.1)	1 (3.6)	15 (5)
Under treatment	59 (48.8)	24(38.1)	22 (78.6)	13 (43.3)
Metastatic	21 (18.2)	15 (23.8)	4 (14.3)	2 (1.7)

Level of PA (METS)				
PRE, M±SD	1371.8± 742.7	1350.3 ± 706.9	1256.7±540.6	1528.9±958.5
LOCKDOWN, M±SD	1012.7± 587.1	1117.2 ±542.1	849.7±570.8	899.3±673.1
INTERVENTION, M±SD	2110.8± 876.5	2567.7 ± 619.6	1747.3±975.4	1311.7±438.7
FOLLOW-UP, M±SD	2056.9± 778.5	2177.9± 557.9	1830.5±724.4	1995.7±1357.6
Sitting time (Hours/week)				
PRE, M±SD	39.6±22.3	33.8 ±2.6	48.8 ± 20.7	43.4 ± 20
LOCKDOWN, M±SD	64.2±51.8	56.8 ±27.8	64.8 ± 25.9	79.6± 92.4
INTERVENTION, M±SD	30.9 ± 20	25.4 ± 13.9	48.5 ± 16.9	26.1 ± 26.9
FOLLOW-UP, M±SD	32.8 ± 17.6	28.6±14.6	38.3 ± 21.3	41 ±17.9
Physical Status				
Fitness Capacity (ml/kg/min), M±SD		26.68±6.5		
Maximal Strength in Chest press (RM), M±SD		17.3±9.6		
Maximal Strength in Leg Press (RM), M±SD		66.4±30.5		
6 minutes walking test (m), M±SD		537.9±75		561.4±109.9
30" Squat Test , M±SD		19.9± 3.4		18.9±7.3
Height (meters) , M±SD	1.62±6.09	1.6±5.9	1.7±6.5	1.62±6.99
Weight (kg), M±SD	63.71 ±11,64	62.9 ±12.2	65.3±12.3	63.87±10,03
BMI (kg/m ²), M±SD		23.4±4.2		
Fat Mass kg/%, M±SD		21.5 ± 9.1		
Lean Mass kg/%, M±SD		21.8 ± 3.2		
Visceral Fat Mass, cm ² , M±SD		106.6±49.6		
Level of Fatigue				
LOCKDOWN, M±SD				37.5 ± 2.2
INTERVENTION, M±SD				39.3 ± 2.3
FOLLOW-UP, M±SD				40.3±2.8

*Assistance: it was considered the number of sessions that patients attended

**Adherence: it was considered the number of patients who kept doing exercise after the physical intervention

7.1. General Results

Physical activity levels decreased by 68.7% in cancer patients during the lockdown, showing a significant reduction between the PRE and LOCKDOWN assessments. However, after the exercise interventions, the cancer patients reported a significant rise of 92% in physical activity levels that was slightly increased at the 3-month FOLLOW-UP assessment (Figure 2). Patients reported an increase of 65.5% in sitting time between the PRE and LOCKDOWN assessments. However, a reduction of 52.9% in sitting time was observed after the exercise interventions, and this reduction was maintained by patients until the FOLLOW-UP assessment (Figure 3).

Related to weight, it did not reach significant changes, with a mean reduction of 570 g [CI 95% -0.07 to 1.23; p=0.08] between the PRE and FOLLOW-UP assessments in all the included patients.

8. Results by Program

8.1. G-ACT

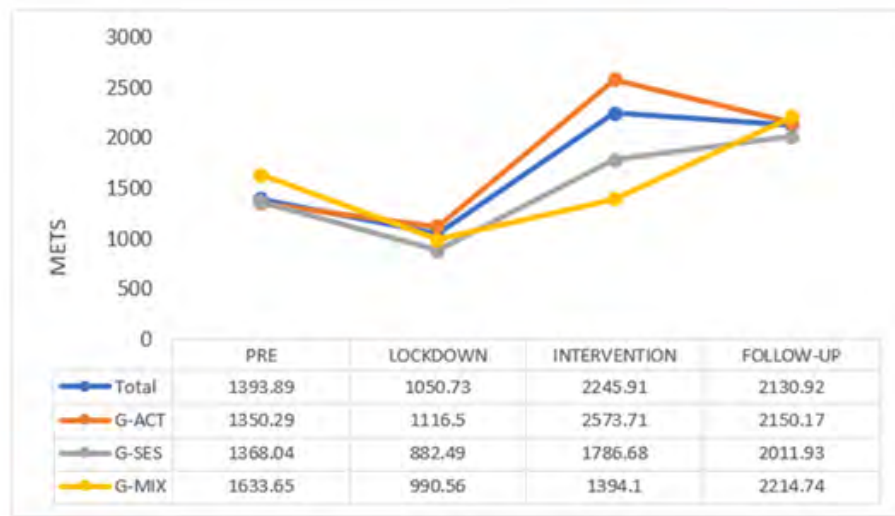
Related to the G-ACT program, a significant reduction in PAL was

observed between the PRE and LOCKDOWN assessments, which was a significant reversal after the exercise intervention. However, a significant reduction at follow-up was observed in these patients. Sitting time showed a significant increase after the lockdown that was significantly reduced after the exercise intervention. This reduction was maintained in the FOLLOW-UP assessment.

8.2. G-SES

Related to the G-SES program, the patients showed significantly higher physical activity levels after the exercise intervention, while no other significant differences were observed between the first two assessments or between the last two assessments.

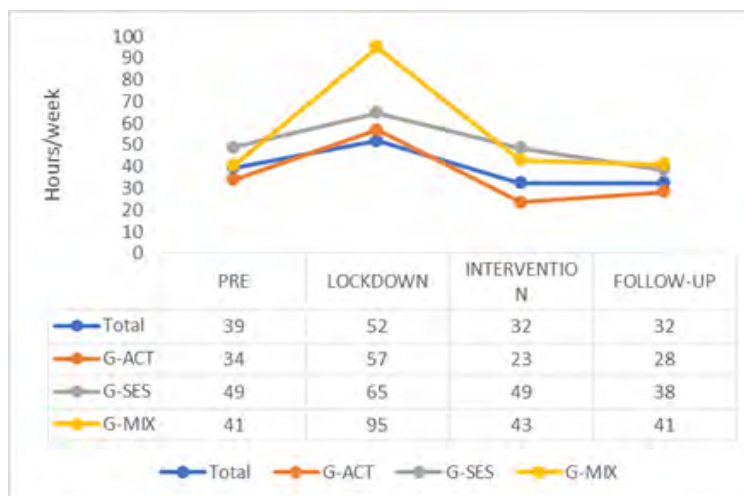
Regarding sitting time in patients who participated in the G-SES program, a significant rise between the PRE and LOCKDOWN time was observed, although a significant reduction was registered in these patients after the exercise intervention. This reduction in sedentary time was maintained in the FOLLOW-UP assessment.



PROGRAM	PRE TO LOCKDOWN	LOCKDOWN TO INTERVENTION	INTERVENTION TO FOLLOW-UP
GENERAL	-454.1 METS IC 95% -692.8 to -215.8 p<0.001	921.6 METS IC 95% 1153.1 to 690.2 p<0.001	-207.4METS IC 95% -105.7 to 520.6 p=0.46
G-ACT	-233.8 METS IC95% -432.8 to -34.8 p=0.013	1457.2 METS IC95% 1232.7 to 1681.6 p<0.001	-423.5 METS IC95% -630.9 to -216.1 p<0.001
G-SES	-485.6 METS IC95% -1085.0 to 113.9 p=0.16	904.2 METS IC 95% 413.9 to 1394.4 p<0.001	225,24 METS IC95% -640.9 to 1091.4 p=1.00
G-MIX	-643,09 METS IC95% -1495.0 to 208.8 p=0.20	403.5 METS IC95% -306.5 to 1113.6 p=0.56	820,64 METS IC95% -506.9 to 2148.1 p=0.42

Results showed by MA, 95%, p value

Figure 2: Changes in physical activity levels in general and between groups analyzed by ANOVA models.



PROGRAM	PRE TO LOCKDOWN	LOCKDOWN TO INTERVENTION	INTERVENTION TO FOLLOW-UP
GENERAL	12.6 hours/week (h/wk) IC 95% 12.1 to 38.5 p<0.001	-19.5 h/wk IC 95% -43.7 - -16.5 p<0.001	-0.06 h/wk IC 95% -3.4 to 5.5 p=0.19
G-ACT	23.0 h/wk IC 95% 28.9 – 17.1 p=0.001	-31.4h/wk IC 95% -37.5 - -25.3 p=0.001	3.2 h/wk IC95% -0.55 to 6.90 p= 0.14
G-SES	16h/wk IC 95% 4.1 to 27.9 p = 0.004	-16.3 h/wk IC 95%. -28.3 to -4.1 p=0.004	-10.3 h/wk IC 95% -22.3 to 1.8 p=0.1
G-MIX	54.5h/wk IC 95% -54.5 to 163.5 p = 0.87	-52.0h/wk IC 95%. -164.7 to 60.7 p=1.0	-2.0 h/wk IC 95% -19.58 to 15.58 p=1.0

Figure 3: Changes in sedentary levels in general and between groups analyzed by ANOVA models.

8.3. G-MIX

Related to the G-MIX program, only the FOLLOW-UP assessment showed a significantly higher PAL than the LOCKDOWN assessment, but no other significant differences were found. In this program, a 6-minute walking test and a 30-second squat test were assessed. A reach with no significant improvement was observed, although a significant increase of 53 meters [an improvement of 9%, p=0.073] was observed in the pre- and post-assessments. In the 30-second squat test, an improvement of only 2 squats was observed [p=0.15]. Regarding patient-reported outcomes, FATIGUE did not reach significant improvement, showing a change of 2.77 points on the FACT-F questionnaire [IC 95% -0.51 to 6.04; p<0.001; p=0.09]. In this group, sitting time increased by a mean

of 54.5 hours/week during the lockdown. In addition, after the exercise intervention, a reduction of a mean of 52 hours in sedentary time was observed, and it was maintained at follow-up. Despite of this, no significant differences were observed.

8.4. Comparisons Between Groups

Related to the effectiveness of the different programs, the main results are shown in (Table 2), where the G-ACT program showed significantly higher improvements in PAL compared with the G-SES and G-MIX programs. In addition, the G-SES program achieved significantly higher changes in PAL after the end of the program compared with the G-MIX program. Sedentary time was significantly reduced in the G-ACT and G-MIX programs compared to the G-SES program once the interventions concluded.

Table 2: Comparisons of physical activity levels and sedentary time between groups

	G-ACT VS G-SES			G-ACT VS G-MIX			G-SES VS G-MIX		
	Mean Dif	IC 95%	p	Mean Dif	IC 95%	p	Mean Dif	IC 95%	p
PHYSICAL ACTIVITY LEVELS (METS)									
PRE	93.6	(-342.6 to 529.7)	1	-178.7	(-614.9 to 257.5)	0.963	-272.2	(-774.2 to 229.8)	0.57
LOCKDOWN	267.5	(-120.1 to 655.2)	1	217.9	(-142.6 to 578.4)	0.431	-49.6	(-500.2 to 400.9)	1
INTERVENTION	660.9	(349.2 to 972.6)	<0.001	1112.1	(773 to 1451.2)	<0.001	451.3	(51.8 to 850.7)	0.027
FOLLOW-UP	120.4	(-282.8 to 523.7)	0.18	-223.8	(-751.5 to 304)	0.402	-344.2	(-858.9 to 170.5)	0.19
LEVELS OF SEDENTARISM (hours/week)									
PRE	-14.9	(-26.8 to -3.1)	0.008	-9.6	(-21.2 to 1.9)	0.14	5.4	(-8.4 to 19.1)	1
LOCKDOWN	-7.9	(-36.3 to 20.3)	1	-22.8	(-50.4 to 4.8)	0.14	-14.8	(-47.6 to 17.9)	0.83
INTERVENTION	-22.2	(-30.2 to -14.3)	<0.001	1.9	(-6 to 9.7)	0.64	24.1	(14.8 to 33.3)	<0.001
FOLLOW-UP	3.1	(-4.7 to 10.8)	0.4	-2.7	(-11.8 to 6.3)	0.55	-5.8	(-15.3 to 3.7)	0.23

9. Discussion

The main objective of this observational study was to evaluate the impact of the lockdown in the levels of physical activity in the cancer population as well as to determine what type of exercise intervention was more effective in increasing physical activity levels in cancer patients during the lockdown. Our results show that lockdown reduced physical activity levels in cancer patients a 68.7%, almost double the time registered in the general population [38%] in the same period. A similar change was observed for sitting time. While the general population showed a rise of 28.6% during the lockdown, in cancer patients, it increased by 65.5% [14], indicating that exercise interventions had a higher impact on cancer patients. Comparisons between groups suggest that a longer intervention with higher levels of supervision [G-ACT] was significantly more effective in increasing physical activity levels and in reducing sedentary time in cancer patients. Adherence to physical activity at the 3-month follow-up was similar in all the provided programs. It is important to highlight that, in general, these three exercise interventions in online models during lockdown have been effective in informing and achieving significant improvements in physical activity levels and reductions in sedentary behaviors. However, it had particularly importance when lockdown restrictions allowed people doing outdoor physical activities, which led them to a more active lifestyle. Related to our results, a longer intervention with a duration of 12 weeks was also more effective in increasing PAL than interventions with a shorter duration. In this sense, programs developed under exercise-oncology specialist supervision are related to higher levels of exercise adherence, which suggests that exercise-oncologist specialists play an essential role in short-term behavioral changes. These results are in concordance with a previous Cochrane Review [2018] were high levels of supervision, intervention with a duration of at least 8 weeks and group interventions are related to levels of adherence of above 75% [18]. Despite of this, it would be interesting to consider the results of the G-MIX program, and the G-SES for two main reasons: 1] These programs needs fewer resources to be settled than the G-ACT program, and 2] the G-MIX and G-SES programs should be interesting interventions to provide in resource-poor environments as well as in emergency scenarios, such as the COVID-19 pandemic lockdown.

In line with this, a recent meta-analysis suggested the importance of the use of various technologies to stimulate and motivate patients in different supervised and home-based programs [3]. For this reason, supported online material mixed with informational activities has been essential for improving PAL during lockdown and maintained it after that period. The most important role of these interventions was related to achieve healthier cancer patients' lifestyle. In previous meta-analysis, it has been observed that around 24% to 50% of breast cancer patients actually decrease their post-diagnosis physical activity levels [10][19][20]. This decline coupled with increased sedentary lifestyles due to lockdown, can trigger

side effects and health problems in cancer patients. This is because of these interventions are essential promoting physical activity at home and preventing different illness associated with a sedentary lifestyle. Another relevant result of these interventions was the reduction in sitting time, especially during the total lockdown, with a mean of 30.1 hours per week. It is well known that sedentarism impacts the human body [21] reducing muscular mass and cardiovascular fitness and impairing metabolism and the endocrine and nervous systems. [22] Moreover, it has been demonstrated that muscle wasting occurs rapidly and is detectable within two days of inactivity, a key aspect that was considered in the application of the online interventions [16]. In line with this, reducing the time of inactivity will improve muscular and cardiovascular function and increase metabolism and nervous system activity, which will have a positive impact on patients' health [23,24]. Although the results of this study are generally positive, we encountered several limitations that have to be considered. First of all, one of the main limitations was the short period of follow-up from the end of the program onward. A follow-up of one year might clarify the importance of each program in long-lasting adherence. Another important limitation was the influence that lockdown had on on-site programs, forcing the adaptation of all of them to online versions. In contrast, it became a strength since this study demonstrated that this type of intervention increases physical activity in cancer patients. Finally, another important limitation is that it was not a randomized study that has been solved with multivariate analysis.

Despite of the limitations, the study was able to show positive results in the three strategies for cancer patients, and because of this, a new online modality has been created that presents many advantages, especially in patients with aggressive treatments, mobility limitations or those who live far from exercise centers. In short, online exercise-oncology strategies for cancer patients that focus on increasing physical activity levels and reducing sedentary behavior are essential to keep cancer patients' health. In addition, these online exercise-oncology interventions will be more effective with longer and supervised programs using platforms that are adapted for group activities. In this sense, a strategy combining home-based and outdoor exercise is highly recommended to achieve exercise with short-term adherence.

10. Conclusion

Online programs were an effective strategy to increase physical activity levels in cancer patients during the lockdown, particularly when the partial lockdown was in effect. A higher level of control and longer intervention were more effective in increasing physical activity levels in cancer patients during and after the lockdown.

11. Statements and Declarations

11.1. Funding: The study was supported by the Spanish Cancer Association, but no financial assistance was needed to carry it out.

11.2. Conflicts of Interest/Competing Interests: All the authors

have approved the manuscript and agree to its submission and it does not exist any conflict of interest.

11.3. Availability of Data and Material: The authors have full control of all the data, and we agree to allow the journal to review these data if requested.

11.4. Authors' Contributions: All authors of this research paper have directly participated in the planning, execution, or analysis of the study. The first draft of the manuscript was written by Soraya Casla and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript at the end of June 2022.

11.5. Ethics Approval: The study was approved by the ethics committee at the Carlos III Health Institute and was conducted following the principles of Declaration of Helsinki.

11.6. Consent to Participate: Participants received all necessary information, and they all signed the written informed consent to participate.

11.7. Consent for Publication: Participants received all necessary information, and they all signed the written informed consent to publish individual's data.

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