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Impact of the COVID-19 pandemic on the physical fitness of older adults: a longitudinal study

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ABSTRACT

Introduction: Older adults, who are considered to be at higher risk of contracting the COVID-19 virus, have been adversely affected by the pandemic. **Objective:** This prospective longitudinal study aimed to verify changes in the physical fitness of older adults during the period of the COVID-19 pandemic, considering gender and age group. **Methods:** Seventy-six older individuals (aged 72.6±6.47 years) who were part of a university extension program participated in the study. Their physical fitness was assessed using the Senior Fitness Test (SFT), which was administered by trained researchers before the pandemic (November 2019) and during the pandemic (April 2022). **Results:** The results showed a significant decline in physical fitness in all tests, except for the Arm Curl Test. The greatest decline was observed in the 6-minute walk test. Both men and women exhibited greater declines in aerobic endurance and lower limb strength. Older adults aged 80 years or older were the most affected, exhibiting the greatest declines, particularly in aerobic endurance and lower limb strength. **Conclusion:** The study concludes that the COVID-19 pandemic had a significant negative impact on the physical fitness of older adults, especially women and those aged 80 years or older. Therefore, physical activity programs should be implemented for these populations to minimize or even reverse the negative impacts caused by COVID-19 on their physical fitness.

Keywords: physical fitness; COVID-19; pliability; muscle strength; aged.

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INTRODUCTION

COVID-19 was declared a pandemic by the World Health Organization in 2020[1] and represented a challenge for the older adults, due to the susceptibility of this age group to the most serious complications of the disease and death[2,3]. The older adults had to adapt to meet the restrictive measures proposed by governments at all levels to control the pandemic, such as social distancing/social isolation[4]. This context has had a negative influence on the lifestyle of this population[5], leading to an increase in sedentary behavior[6-8] and a decrease in physical activity[5,7,9].

Cunningham and Sullivan[10] indicate that there will be an increase in the number of older people who do not comply with physical activity guidelines due to the impacts of COVID-19. A low level of physical activity is considered a major public health problem

and a relevant risk factor for decreased life expectancy and many physical health problems[11]. In this way, the role of regular physical activity on physical fitness levels stands out, a factor that is fundamental to establishing a balance in the quality of life of the older adults[12].

Physical fitness is extremely important for the health of the population[13]. A meta-analysis involving almost two million people found that higher levels of upper and lower limb muscle strength are associated with a lower risk of mortality in the adult population[14]. Similarly, better cardiorespiratory fitness is associated with a lower risk of death from all causes and cardiovascular diseases[15]. Better levels of physical fitness seem to delay mortality, especially due to the reduction in cardiovascular disease and cancer rates[16]. This context has become even more important during the pandemic period, as the physical fitness of the older adults has been severely affected, especially in people infected by the virus[17].

Given the restrictions caused by the pandemic on the long-term physical fitness of the older adults, the lack of longitudinal studies, and the need for effective interventions by health professionals, it is important to investigate the impact of the COVID-19 pandemic on the physical fitness of the older aduls. The originality of this study lies in the combination of the assessment of a specific demographic group, a longitudinal approach, a multidimensional assessment of physical fitness, and the contextualization of changes during a pandemic period. Thus, the research addresses a significant knowledge gap and offers valuable insights into the field of health and aging amid challenging circumstances. Assessing physical fitness will help to plan interventions, including physical exercise, that aim to reduce or even reverse the consequences of COVID-19 on the health of older people[10].

Therefore, this study aims to verify changes in the physical fitness of the older adults during the COVID-19 pandemic, according to gender and age group.

METHODS

This was a prospective longitudinal study, approved by the Ethics Committee for Research Involving Human Beings of the Santa Catarina State University (UDESC) under No. 4.886.615. All study participants signed an informed consent form. The older adult participants in the study were part of the university extension program *Grupo de Estudos da Terceira Idade* (GETI) at UDESC, in Florianópolis/SC, Brazil, and met the following inclusion criteria: 60 years of age or older, of both sexes and who took the Senior Fitness Test (SFT)[18] in November 2019 [T1] and April 2022 [T2].

Only older adults people who did not take the physical tests in 2022, for whatever reason, were excluded from the study. In 2019, 98 older adults (71 women and 27 men) underwent the tests; of these, 22 were not assessed again in 2022, which resulted in a sample loss of 22.4%. As a result, 76 older adults took part in the study, 60 women and 16 men.

Variables

To characterize the sample, a questionnaire was drawn up with questions about sociodemographic characteristics (age, gender, marital status, and schooling), health conditions (self-reported diseases and perception of health status), and questions about COVID-19 (whether they had the disease, whether they had taken the vaccine and the number of doses). This information was collected upon returning from the program's face-to-face activities, through an individual interview in April 2022. Physical fitness variables were assessed using the SFT battery, which consists of six physical tests that assess strength, flexibility, agility/dynamic balance, and aerobic endurance[18].

Lower limb strength

Assessed using the Chair Stand Test, in which the participant begins by sitting on the chair with their back against the backrest, feet on the floor, and arms crossed in front of the body with the middle finger towards the acromion. At the assessor's signal, the participant rises to a standing position and then returns to the sitting position. The score is obtained according to the total number of correct repetitions in a 30-second interval[18].

Upper limb strength

Assessed using the Arm Curl Test in which the participant sits on a chair with their back straight and their feet on the floor and holds a dumbbell with their preferred/dominant hand. The test begins with the arm extended near the chair, perpendicular to the floor. At the signal, the participant flexes the elbow to the full range of motion and then returns the arm to a fully extended position (starting position). The score is obtained according to the total number of correct repetitions in a 30-second interval[18].

Lower limb flexibility

Assessed by the Chair Sit and Reach test in which the participant sits on a chair with their legs facing forwards, keeping one leg bent and the foot on the floor, knees parallel, facing forwards, the participant extends the other leg (the preferred/dominant leg) in front of the hip, with the heel on the floor and plantar dorsiflexion at approximately 90º. With the leg extended, the participant slowly leans forward and tries to touch their toes by slipping their hands, one on top of the other, with the tips of their middle fingers, on the extended leg (ruler). The assessor records the distance (cm) to the toes (negative result) or the distance (cm) that can be reached beyond the toes (positive result). The middle of the hallux represents the zero point[18].

Upper limb flexibility

Assessed by the Back Scratch Test in which the participant stands and places their hand on the same shoulder, palm open and fingers extended, reaching as far as possible towards the middle of the back. The hand of the other arm is placed on the back, palm up, reaching as far back as possible in an attempt to touch or overlap the middle fingers of both hands. The evaluator records the distance (cm) between the fingers of the two hands (negative result) or the distance (cm) that the fingers of the hands can overlap (positive result)[18].

Agility and dynamic balance

Assessed by the 8-Foot Up and Go Test, in which the participant begins by sitting in the chair with an upright posture, hands on thighs and feet on the floor with one foot slightly in front of the other. At the signal, the participant gets up from the chair, walks as quickly as possible around the cone, returns to the chair, and sits down. The result corresponds to the time elapsed between the "start" signal and the moment the participant is seated in the chair[18].

Aerobic endurance

Assessed using the 6-minute walk test, in which the older adult walk as fast as possible (without running) around a 50-meter rectangular path as many times as they can within the time limit. During the test, participants can stop and rest, if necessary, and then start walking again. The evaluator must move onto the course after all the participants have started and must report the time elapsed. The test score is the distance covered by the older adult, in meters, within 6 minutes[18].

The use of this battery is noteworthy because it is specific for the older adult, the physical tests are easy to apply, the operational cost is low, it has been validated for the older adult population[19] and it has been used in different countries and Brazil[20]. The battery of physical tests was administered to the older adult in November 2019 (before the COVID-19 pandemic) and April 2022 (after the return of the university extension program activities), by trained assessors. The tests were applied in a circuit format, following the sequence of the SFT battery tests, according to the test protocols proposed by Rikli and Jones[18].

Data analysis

The data was stored in Excel and analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 20.0. Initially, the normality of the data was checked using the Kolmogorov-Smirnov test. The variables were analyzed descriptively using simple frequencies and percentages (categorical variables) and measures of position and dispersion (numerical variables). The paired t-test was used to identify possible average differences in the physical fitness variables of the older ault before the COVID-19 pandemic (T1) and during the pandemic (T2), after returning to the university program activities in person.

The mean differences between the two moments (T1 and T2) were also analyzed by gender subgroups (male; female) and age group (60-69 years; 70-79 years; 80 years or more). The effect size was checked using Cohen's d[21] and the results were interpreted according to low (0.2-0.4), moderate (0.5-0.7), or large (≥0.8) effect sizes. A significance level of 5% was used for all analyses.

RESULTS

Seventy-six older adults took part in the study (72.6 years; SD=6.47), 60 women and 16 men. As for sociodemographic characteristics, half of the older adults live with a partner (n=38) and most (46.0%) have completed high school. Regarding health conditions, 76.3% of the older adults reported having some illness and 94.8% considered their general state of health to be positive. In addition, among the older adults who answered the questions about COVID-19 (n=58), 81.0% said they had not been infected by the disease and all the older adults reported having had at least one dose of the vaccine against the virus; of these, 11 older adults had two doses, while 47 had received both doses plus a booster (Table 1).

Table 1: Characteristics of the older adults participating in the study (n=76).

Variables	Results
Age $^{X\ (DP)}$	72.6 (6.47)
Sex $^{f\ (\%)}$	
Female	60 (79.0)
Male	16 (21.0)
Marital status $^{f\ (\%)}$	
With a partner	38 (50.0)
Without a partner	38 (50.0)
Education $^{f\ (\%)}$	
Illiterate	8 (10.5)
Elementary School	35 (46.0)
High School	31 (40.8)
Higher Education	2 (2.7)
Diseases $^{f\ (\%)}$	
Yes	58 (76.3)
No	18 (23.7)
Perception of health (n=58) $^{f\ (\%)}$	
Positive	55 (94.8)
Negative	3 (5.2)
COVID-19 (n=58) $^{f\ (\%)}$	
Yes	8 (13.8)
No	47 (81.0)
Don't know	3 (5.2)
COVID-19 vaccine (n=58) $^{f\ (\%)}$	
Yes	58 (100.0)
COVID-19 vaccine doses (n=58) $^{f\ (\%)}$	
Two doses	11 (19.0)
Two doses + booster	47 (81.0)

Legend: X= mean; SD= standard deviation; n= sample; f= simple frequency.

Table 2 shows the results of the mean difference in physical fitness tests before (T1) and during (T2) the COVID-19 pandemic. In general, the older adult had a significant worsening in all physical fitness tests, except Arm Curl. The largest effect size was seen in the 6-minute walk (d=0.99) (Table 2).

Table 3 describes the results obtained in the tests before (T1) and during (T2) the COVID-19 pandemic according to the sex of the older adult. Among men, it was possible to see a significant worsening in the Chair Stand Test, Back Scratch Test, and 6-minute walk tests; however, the largest effect sizes were identified in aerobic endurance (d=0.63) and lower limb strength (d=0.38). In women, the worsening occurred in all the tests, except Arm Curl; aerobic endurance (d=1.09) and lower limb strength (d=0.57) stood out, with large and moderate effect sizes, respectively (Table 3).

Table 4 shows the results obtained in the physical fitness tests before (T1) and during (T2) the COVID-19 pandemic, based on a comparison between the age groups of the older adult. Among the younger participants, the negatively impacted skills were aerobic

Table 2: Mean difference in physical fitness variables of older adults before (T1) and during (T2) the COVID-19 pandemic (n=76).

Variables	T1 X (SD)	T2 X (SD)	t	p-value	d Cohen
Stand and Sit Test (reps)	15.1 (4.17)	13.0 (3.93)	7.749	<0.001	0.52
Arm Curl Test (reps)	15.2 (4.21)	15.0 (3.74)	0.515	0.608	0.05
Chair Sit and Reach Test (cm)	1.8 (11.39)	-0.03 (8.66)	2.441	0.017	0.17
Back Scratch Test (cm)	-12.1 (14.98)	-15.4 (15.72)	3.796	<0.001	-0.21
Agility and balance (s)	6.10 (1.39)	6.53 (2.20)	-2.414	0.018	-0.23
6-minute walk (m)	534.1 (69.91)	453.5 (91.88)	10.325	<0.001	0.99

X=mean; SD=standard deviation; reps=repetitions; cm=centimeters; s=seconds; m=meters;.

Table 3: Mean difference in physical fitness variables and general physical fitness index (GPAI) before (T1) and during (T2) the COVID-19 pandemic, according to the sex of the older adults (n=76).

Variables	Male (n=16)		p-value	d Cohen	Female (n=60)		p-value	d Cohen
	T1 X (SD)	T2 X (SD)			T1 X (SD)	T2 X (SD)		
Stand and Sit Test (reps)	14.9 (5.73)	12.7 (5.90)	0.001	0.38	15.1 (3.66)	13.1 (3.22)	<0.001	0.57
Arm Curl (reps)	14.9 (5.19)	15.8 (4.28)	0.236	-0.18	15.3 (3.93)	14.7 (3.58)	0.256	0.12
Chair Sit and Reach Test (cm)	-9.8 (10.06)	-7.0 (6.98)	0.135	-0.31	5.1 (9.45)	2.0 (8.07)	<0.001	0.35
Back Scratch Test (cm)	-17.9 (16.14)	-21.4 (15.80)	0.024	0.22	-10.4 (14.30)	-13.6 (15.38)	0.003	0.22
Agility and balance (s)	6.72 (1.98)	7.16 (2.10)	0.248	-0.21	5.92 (1.14)	6.35 (2.21)	0.042	-0.21
6-minute walk (m)	550.9 (88.36)	459.1 (136.01)	<0.001	0.63	529.2 (63.70)	451.9 (76.11)	<0.001	1.09

Legend: X= mean; SD=standard deviation; reps=repetitions; cm=centimeters; s=seconds; m=meters;

Table 4: Mean difference in SFT tests before (T1) and during (T2) the COVID-19 pandemic, according to the age group of the older adults (n=76).

Age groups	SFT1 (reps)		p-value	d Cohen	SFT2 (reps)		p-value	d Cohen
	T1 X (SD)	T2 X (SD)			T1 X (SD)	T2 X (SD)		
60 to 69 years old (n=24)	16.4 (4.14)	14.3 (4.14)	<0.001	0.52	15.1 (4.18)	15.7 (3.42)	0.404	-0.15
70 to 79 years old (n=45)	14.6 (4.22)	12.7 (3.72)	<0.001	0.47	15.4 (4.29)	14.8 (3.94)	0.274	0.14
80 years or older (n=7)	13.4 (2.99)	11.0 (3.83)	0.043	0.68	14.3 (4.35)	14.0 (3.65)	0.808	0.07
	SFT3 (cm)		p-value	d Cohen	SFT4 (cm)		p-value	d Cohen
	T1 X (SD)	T2 X (SD)			T1 X (SD)	T2 X (SD)		
60 to 69 years old (n=24)	3.3 (11.53)	1.7 (10.87)	0.199	0.14	-4.4 (14.69)	-7.1 (15.26)	0.120	0.18
70 to 79 years old (n=45)	2.4 (11.21)	-0.5 (7.84)	0.002	0.25	-16.2 (13.98)	-20.2 (14.68)	0.002	0.28
80 years or older (n=7)	-7.3 (9.32)	-2.9 (3.29)	0.212	-0.57	-12.1 (13.64)	-13.7 (13.0)	0.280	0.12
	SFT5 (s)		p-value	d Cohen	SFT6 (m)		p valor	d Cohen
	T1 X (SD)	T2 X (SD)			T1 X (SD)	T2 X (DP)		
60 to 69 years old (n=24)	6.07 (1.66)	6.78 (3.32)	0.185	-0.23	567.9 (62.03)	490.7 (67.58)	<0.001	1.19
70 to 79 years old (n=45)	6.01 (0.91)	6.31 (1.09)	0.026	-0.29	520.2 (71.99)	437.7 (102.73)	<0.001	0.87
80 years or older (n=7)	6.76 (2.65)	7.15 (2.87)	0.148	-0.13	493.3 (14.0)	412.7 (45.6)	0.005	2.05

FT1 = strength of the lower limbs; SFT2 = strength of the upper limbs; SFT3 = flexibility of the lower limbs; SFT4 = flexibility of the upper limbs; SFT5 = agility and dynamic balance; SFT6 = aerobic endurance; X = mean; SD = standard deviation; reps = repetitions; cm = centimeters; s = seconds; m = meters.

endurance (d=1.19) and lower limb strength (d=0.52). Among the older adults aged between 70 and 79, only upper limb strength did not worsen at the second collection point; in addition, aerobic endurance (d=0.87) and lower limb strength (d=0.47) were the skills with the greatest negative impact. Among the older adults aged 80 and over, only aerobic endurance (d=2.05) and lower limb strength (d=0.68) worsened during the pandemic compared to the pre-pandemic period (Table 4).

DISCUSSION

This study showed that the period of social isolation caused by the COVID-19 pandemic resulted in a significant decrease in all the physical fitness variables assessed in older adults, except for upper limb strength. It is noteworthy that aerobic endurance worsened with a medium effect size in men and a large effect in women and all age groups analyzed. In addition, lower limb muscle strength worsened with a medium effect size in women and the older adults aged between 60 and 69 and 80 and over.

Isolation actions due to the COVID-19 pandemic have changed the habits and routines of the older adults[4], as they are considered more vulnerable, since they are more at risk of developing the clinically severe form of COVID-19, due to the high rate of multiple associated morbidities that arise in the aging process. Studies show that social distancing due to the COVID-19 pandemic has influenced individuals' lifestyles[5], increasing sedentary behavior[6,8] and reducing physical activity[5,7,9]. Reduced physical activity is a risk factor for increased health problems and shorter life expectancy[11].

The interruption of activities, especially exercise, has negative effects on the functional capacities of the older adults; a period of interruption of 11 weeks is enough to cause a decline in the physical abilities of the older adults, such as muscular strength and endurance, flexibility, mobility, and dynamic balance[22]. Studies have also verified the decline in strength caused by a four-week break from exercise and found that the older adults lost 32% of their maximum strength[23] and decreased the one-repetition maximum (1RM) by 6.4 kg[24].

Another factor that may also have contributed to the decline in physical fitness during the pandemic period was the presence of comorbidities, since 76.3% of the participants reported some disease, with hypertension being the most prevalent. The literature shows that physical fitness components are related to the presence of comorbidities; a recent meta-analysis showed an association between cardiovascular diseases and cardiorespiratory fitness[25]. In addition, high blood pressure values, which characterize hypertension, are also related to worse cardiorespiratory capacity[26].

A study also shows that men in the 60-69 and 70-80 age groups had a 12% loss of muscle mass in the lower limbs and 8% in the upper limbs, while women in the same age groups had a 14% loss of muscle mass in the lower limbs and 10% in the upper limbs[27]. These data, to a certain extent, support the results found in this study, which showed a more marked loss in the physical abilities of women compared to men. The loss of muscle mass may explain the decrease in muscle strength over time, causing the older adults to perform worse in strength tests, especially in the lower limbs.

In addition, there are physiological and morphofunctional differences between the sexes, especially due to hormonal action, which have a different impact on the neuromuscular, metabolic, and morphofunctional responses of these two groups[28]. Men have a greater muscular capacity to generate maximum strength, while women have higher levels of flexibility and joint range of motion[28]. It is, therefore, possible to infer that, just as there will be different responses between the sexes in terms of adaptations to physical exercise, there will also be differences in physical inactivity and the measures of social distancing caused by the pandemic, which will have a direct impact on the physical health of the older adults.

Women also showed a greater negative effect on aerobic endurance compared to men. Tomkison et al.[29], when assessing the impact of time on the performance of the 6-minute walk test, also found that women worsened by a greater percentage than men. Although men show a greater loss of $VO2_{max}$ than women throughout their lives, it seems that this difference is eliminated at older ages[30]. Furthermore, when looking at the specificity of the test applied in this study, it should be noted that variables other than those related to aerobic capacity may have an impact on the results obtained and the differences between men and women over 60.

When looking at the results by age group, all the older adults showed significant losses, especially in lower limb strength and aerobic endurance. In strength, a moderate effect size was found in all age groups; however, when analyzing aerobic endurance, the group aged 80 and over showed a greater impact. Research in the area of aging shows that there is consistency in the results obtained. According to a study by Araújo et al.[31], the loss of bone mass starts to occur from the age of 50, and it is also around the age of 50 that decreases in female and male sex hormones begin, which can reach a drop of 65% by the age of 75, impacting on bone mass, muscle mass and strength in the older adults. The same study also points out that muscle mass, which is constant up to the age of 40, begins to suffer an accelerated loss from that age onwards, and can reach 40% by the age of 80, and 50% by the age of 90, progressively impacting on muscular endurance and strength.

Corroborating these findings, research by McArdle et al.[32] points out that by the age of 70, the cross-sectional area of skeletal muscle is reduced by between 25 and 30% and muscle strength by between 30 and 40%, the latter maintaining a rate of loss of 1 to 2% per year. With advancing age, there is a natural loss of muscle mass, together with a decrease in levels of physical activity, impacting a decrease in muscle strength for both men and women[27]. In people aged 80 and over, the decline in strength and muscle mass can reach 50%[33].

In the same vein, a characteristic found in the older adults aged 80 and over is a low level of physical activity[34], which contributes to marked declines in neuromuscular skills (strength, power, and endurance), resulting in muscle atrophy and sarcopenia[35] and which can be intensified by the prolonged disuse of neural and musculoskeletal structures[36]. Regarding aerobic capacity, it was also found that from the age of 30, there is a decline of around 5% in $VO2_{max}$ capacity per decade, while men aged 70 had a drop of 23.2% in 10 years[37].

To ensure that the older adults are not harmed in the short and long term by the impact of the COVID-19 pandemic, it is important to have public policies to encourage, inform, and implement physical activity programs that promote the older adults to achieve the recommended levels of physical activity[10]. A review study showed that physical exercise protocols for the long-lived older adults that include strength, power, aerobic endurance, flexibility, balance, and joint mobility exercises are effective in attenuating or minimizing the declines resulting from the aging process, improving aspects such as gait, the rate of falls and functional capacity[38].

This study had some limitations. Although they were trained to administer the SFT, the tests were administered by different professionals in each collection period (November 2019 and April 2022), which increases the possibility of bias. In addition, some participants who took the tests in 2019 did not retake them in 2022 because they were no longer participating in the GETI program, resulting in sample loss. Another limitation is the lack of information on control variables, such as the physical activities practiced by the older adults during the COVID-19 period. Despite being offered, the activities had low take-up by the older adults, making it difficult to use this information as a control in the analysis. On the other hand, the study was able to reliably track the changes that had occurred through longitudinal monitoring, as well as using objective measures of physical fitness, such as the SFT battery, which enables assessment and helps to prescribe exercises for the older adults.

Conclusion

The results of this research show that the COVID-19 pandemic has resulted in a significant decrease in the physical abilities of the older adults, especially women among participants over the age of 80. Practicing and maintaining physical exercise is recommended to reverse this situation, regardless of social isolation. In this respect, health professionals should promote physical activity for the older adults, especially given the impact of the COVID-19 pandemic on the health of this population.

The findings of this study could not only help future research into the consequences of social distancing on the health of the older adults during the pandemic but also lead to the planning of strategies for both rehabilitation and prevention in cases of exceptional and severe situations such as the COVID-19 pandemic. As a suggestion for future studies, we recommend a more in-depth investigation into the impacts of social distancing on the physical and mental health of the older adults, to observe the proportion to which the decline in physical health influences mental health, and vice versa, or even if they occur simultaneously, and this evaluation can be done through the joint use of both objective measures of physical fitness and a questionnaire on the perception of mental health.

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