Development of physical motor performance in university students through distance Physical Education in the context of COVID-19[1]

Desarrollo del rendimiento físico motor en estudiantes universitarios a través de la Educación Física a distancia en el contexto de la COVID-19

Desenvolvimento do desempenho físico motor em estudantes universitários por meio da Educação Física a distância no contexto da COVID-19

Borys Bismark León-Reyes*[2], Daniel David Hechavarría Cardero**[3], Marjorie Fabiola Romero Granda***[4], Vicente Anderson Aguinda Cajape***[5], Yaidelys Piz Herrero****[6], Camilo Fernando León Reyes*****[7]
Universidad Estatal de Milagro*, Haciendas Family & Fitness Club**, Universidad Técnica de Machala***, Universidad de Ciencias de la Cultura Física y el Deporte****, Instituto Superior Tecnológico de Formación Profesional Administrativa y Comercial*****

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Autor de correspondencia: Borys Bismark León-Reyes, borysleonreyes@gmail.com

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Abstract

Objective: to evaluate the effects of distance physical education on the motor performance of university students during the COVID-19 pandemic. **Methodology:** study quantitative, correlational and longitudinal design. A total of 103 university students were examined, following a 12-week program divided into three stages, using online distance education. Measurements included abdominal endurance strength, upper waist quick strength, lower extremity explosive strength, and recovery from physical stimulus. Data from weeks 2 (diagnostic), 8 (partial assessment) and 13 (final assessment) were compared. Non-parametric and descriptive

[2] https://orcid.org/0000-0001-6936-9947
[3] https://orcid.org/0000-0002-9541-7567
[4] https://orcid.org/0009-0000-1576-8977
[5] https://orcid.org/0009-0000-5910-2237
[6] https://orcid.org/0000-0003-0975-6368
[7] https://orcid.org/0000-0003-3385-7900

statistics were used for the analysis. **Results:** significant changes were observed in body weight, unobstructed long jump distance and pulse rate before and after the session. **Conclusions:** distance physical education had positive effects on body weight reduction, development of explosive strength in the lower extremities and improvement of recovery capacity in university students.

Keywords: Teleeducation; Physical Condition; Pandemics; Teaching Strategies; Evaluation; Educational Adaptation.

Resumen

Objetivo: evaluar los efectos de la educación física a distancia en el rendimiento motor de estudiantes universitarios durante la pandemia de COVID-19. **Metodología:** estudio de enfoque cuantitativo, de tipo correlacional y diseño longitudinal. Fueron examinados 103 estudiantes universitarios, siguiendo un programa de 12 semanas dividido en tres etapas, utilizando educación a distancia en línea. Las mediciones incluyeron fuerza de resistencia abdominal, fuerza rápida de la parte superior de la cintura, fuerza explosiva de las extremidades inferiores y recuperación del estímulo físico. Se compararon los datos de las semanas 2 (diagnóstico), 8 (evaluación parcial) y 13 (evaluación final). Para el análisis se utilizó estadística no paramétrica y descriptiva. **Resultados:** se observaron cambios significativos en el peso corporal, la distancia de salto de longitud sin obstáculos y la frecuencia del pulso antes y después de la sesión. **Conclusiones:** la educación física a distancia tuvo efectos positivos en la reducción del peso corporal, el desarrollo de fuerza explosiva en las extremidades inferiores y la mejora de la capacidad de recuperación en estudiantes universitarios.

Palabras clave: Teleducación; Condición Física; Pandemia; Estrategias de Enseñanza; Evaluación; Adaptación Educativa.

Resumo

Objetivo: avaliar os efeitos da educação física à distância no desempenho motor de estudantes universitários durante a pandemia da COVID-19. **Metodologia:** estudo quantitativo, correlacional e longitudinal. Foram examinados 103 estudantes universitários, seguindo um programa de 12 semanas dividido em três etapas, utilizando educação à distância online. As medições incluíram a força de resistência abdominal, a força rápida da cintura superior, a força explosiva dos membros inferiores e a recuperação do estímulo físico. Foram comparados os dados das semanas 2 (diagnóstico), 8 (avaliação parcial) e 13 (avaliação final). Para a análise foram utilizadas estatísticas não-paramétricas e descritivas. **Resultados:** foram observadas alterações significativas no peso corporal, na distância do salto em distância sem obstáculos e na frequência de pulso antes e depois da sessão. **Conclusões:** a educação física à distância teve efeitos positivos na redução do peso corporal, no desenvolvimento da força explosiva nos membros inferiores e na melhoria da capacidade de recuperação em estudantes universitários.

Palavras chave: Teleeducação; Condição Física; Pandemias; Estratégias de Ensino; Avaliação; Adaptação Educativa.

Introduction

Optimal performance and the sustainability of university students' productivity, both as undergraduates and later as professionals, are closely related to motor physical performance. The latter is an expression of a person's health as it is closely related to quality of life. Good motor physical performance will contribute to sustaining the optimal cognitive function of the university community members (Redondo-Flórez et al., 2022; Guevara et al., 2025; Ramos-Campo & Clemente-Suárez, 2024). Among the health-related dimensions, motor physical performance includes body composition and muscular strengthening. It also encompasses muscle endurance, muscle strength, agility, and flexibility. Balance, coordination, reaction time, and speed are components of motor physical performance that are essential for the execution of general and specific motor skills required in the profession that students will pursue after graduation. For example, a favorable association between academic performance and cardiorespiratory fitness is estimated (Ryan et al., 2015; Ferreira & Teixeira, 2021; Delito, 2023).

The components of motor physical performance are interrelated and show interdependence among each other to enhance the effectiveness of one another, as can be seen in the improvement of motor skills (Gaspari et al., 2024; Akbar et al., 2021; Fort-Vanmeerhaeghe et al., 2016; Shahzad et al., 2024; Godara, 2016). Similarly, flexibility is related to the maximum range of joint motion without causing injury (De La Motte et al., 2017; Gaspari et al., 2024; Shahzad et al., 2024). On the other hand, to quickly change the direction of body position, an essential component among coordinative physical abilities is agility, complemented by muscular strength developed to enable the musculoskeletal system to withstand and overcome mechanical resistances encountered by university students during physical education classes, voluntary practice of recreational sports, or physical activities required at some point as part of their future profession or social situation (Gaspari et al., 2024; Akbar et al., 2021; León-Reyes et al., 2021a; Mora-González et al., 2019; Morādi et al., 2019; Fort-Vanmeerhaeghe et al., 2016; Shahzad et al., 2024; Godara, 2016).

The educational space primarily responsible for improving motor physical performance in the context of higher education is physical education implemented in the curriculum through the organizational form of the class designed in the subject of the same name. This has been done in a manner without major transformations in the dynamics of the teaching-learning process until 2020, the year when the presence of COVID-19 extended due to its easy spread and limited knowledge of the virus. A respiratory disease caused by the SARS-CoV-2 coronavirus, which from March of that same year onwards was considered by the World Health Organization (WHO) as a pandemic due to the exponential increase in the number of infections. This led to the necessary and vital establishment of extreme political and health measures such as isolation and quarantine, which involved the closure of universities in order to contain the growing spread and number of infected individuals (Varea et al., 2020; Zheng et al., 2021; Merino-Campos & Del-Castillo, 2025; Deng et al., 2020).

From then on, the educational process of universities had to adjust to the recommendations and guidelines of the competent health authority regarding restrictions associated with physical and social distancing. Physical and social distancing measures brought about profound changes in teaching and learning processes, emphasizing the interrelationship of personal components, namely teachers and students, and the latter among themselves, as they were deprived of face-to-face contact. One of the most affected in this regard were subjects related to the sciences of physical activity and sports, such as physical education (Varea et al., 2020; Brien et al., 2022; Olanescu et al., 2022; Fang et al., 2021).

From the initial cessation of teaching activities, the need to restart them emerged until more solutions to contain the pandemic appeared, which forced the accelerated and widespread implementation of distance education models that were already known but were worked on very specifically for certain careers and programs to an almost absolute level of generality in some universities, demanding a new projection of teaching by a faculty that was not fully prepared, especially to take advantage of the benefits of digital platforms, online resources, and the potential of virtuality (Chen et al., 2024; Zakharova et al., 2024; Song & Tang, 2024; Sözler, 2024; Khamzatova et al., 2024; Levytska, 2024; Duterte, 2024; Chetyrova, 2024; Zhou, 2024). On the other hand, it should also be clarified that not all technological and architectural infrastructure was available for its use, as it required an increase in wifi devices, mobile phones, computers for students and teachers, and in the specific case of physical education, spaces in the home for university students to perform physical activities, as mentioned by León-Reyes et al. (2021a), "this must be done in a planned manner, considering digital communication applications, work sessions, digital instruments for personalized treatment" (p. 62).

Facing all these transformations had pronounced psychological effects, in addition to those generated by the risks of the disease, which were related to the uncertainty of how processes would develop in the dynamic imposed by the pandemic, such as teaching and particularly its practices. In this way, the entire situation was experienced by teachers and students with apprehension and some fear, especially the university community directly linked to physical education because in this particular case, changes were more pronounced since the human body was involved in all senses with its emotions in learning due to requiring the essential bodily-motor experience, the bodily practices of activity as a form of teaching had to be changed to sitting and receiving information throughout the day (Ali et al., 2021; Dalpati et al., 2022; Mehr et al., 2024; Randall et al., 2021; Tortella et al., 2021).

Taking this viewpoint into account, it could be said that physical education has been significantly affected by the changes brought about by the pandemic. These changes are due to its large volume of practical content, which has meant that teachers have had to make methodological and didactic adjustments to meet the content to be assimilated by students so that they have the motor skills and physical capabilities required in the subject (León-Reyes et al., 2023). Consequently, university physical education teachers found themselves in the need to substantially transform their teaching activity and the teaching-learning process, transitioning to distance education assisted in its entirety by ICT with an immediate character. From basic knowledge and habits of internet usage restricted to social networks and email, projects of distance learning were created, supported by applications such as Meet, Zoom, Jitsi, or Microsoft Teams. Synchronously with online conferences and

asynchronously through recorded videoconferences complemented with PowerPoint presentations for students who were not present at the time of the class due to connection difficulties.

In the case of Physical Education in this new teaching context, the use of visual media to present and analyze human movement and bodily practices, moving classes from sports fields and pools to computer screens or mobile phones, was vital. There was a readjustment of spaces and materials, including new contents and pedagogical activities, addressed with other methodological strategies, establishing new forms of communication and interaction with students. The latter also had to face a completely different teaching-learning process assisted by a virtual system of guidance and feedback.

This transformation process and significant changes in the context of distancing have been addressed by multiple researchers, delving into various aspects such as the quality of online physical education classes (Yu & Jee, 2021), physical education teaching during the COVID-19 pandemic (Almonacid-Fierro et al., 2022), students' perception of physical education assisted by online learning platforms (Jumareng et al., 2021), modifications of physical activity due to the COVID-19 context (Durdová & Sekot, 2021), the association between physical activity and academic performance, among others (Bustamante-Ara et al., 2020), challenges for initial training in Physical Education (Almonacid-Fierro et al., 2021), satisfaction levels with online physical education classes in universities (Flores et al., 2021), and the daily physical activities of university students (Panenggak et al., 2022). However, these studies have mainly focused on methodological issues, implications on other variables, and not on the motor physical performance achieved by students through the implementation of distance-oriented and controlled activities via digital platforms.

Addressing this limitation, this study aims to determine the effects of physical education programs developed in the distance learning mode, assuming that the development of content-oriented and distance-controlled systems through digital platforms will contribute to increasing the motor physical performance of university students.

Methodology

A random sample of 103 university students was drawn from a population of 206, selected based on inclusion criteria: systematic participation in a course or period and not being subject to curricular adjustments due to disabling pathologies. The sample had a mean age of 21±4 years and a height of 163±11 cm. There was a predominance of females (73.8%), primarily enrolled in clinical psychology. 54 students were from the 2020 class, and 47.6% were enrolled in the 2021 class. In the 2020 class, 68.5% were female and 17 were male. For females, the mean age and height were 20±4 years and 160±10 cm, respectively, while for males, they were 22±5 years and 171±8 cm. Significant differences were observed between sex and university career ($X2= 5.667$; $p=0.017$).

In the 2021 class, this difference was more pronounced, with 79.6% female and 20.4% male students. The sample was grouped into three class groups according to the semester of the physical education course. Group I consisted of 54 students from the second semester of the 2020 class, Group II comprised 25 students from

the first semester of the 2021 class, and Group III included 24 students from the second semester of the 2021 class.

Non-parametric vertical contrast statistics were used, including the Mann-Whitney U test, Wilcoxon signed-rank test, and Kruskal-Wallis test, as well as horizontal contrast analysis using the Wilcoxon signed-rank test, all at a significance level of α=0.05. Descriptive statistics included arithmetic mean and standard deviation to assess position and dispersion, respectively.

Anthropometric measurements were taken using a stadiometer and scale, pulse rate was recorded over a 60-second period, and tests for abdominal and arm strength, long jump, and endurance were conducted. Each subject underwent three tests while completing the course to determine changes resulting from the physical performance program. A 12-week physical content system divided into regenerative, extensive, and intensive stages, controlled, and guided through online distance education, was implemented between each test. Measurements included abdominal endurance strength, upper body quick strength, explosive lower limb strength, and physical stimulus recovery as an expression of overall endurance. A horizontal contrast study was conducted between data recorded for each subject in week 2 (diagnosis) and week 13 (final evaluation). Based on these criteria, the following hypotheses were formulated:

- H_0: There are no changes in motor physical performance with the application of a content system oriented and controlled at a distance through ICT.
- H_1: There are changes in motor physical performance with the application of a content system oriented and controlled at a distance through ICT.
- H_2: There are differences between students from the 2020 and 2021 classes.
- H_3: There are changes between groups of students from each semester.

Results

En la initial measurement, university students showed a weight above the average. This trend was also observed in the arm strength and standing long jump tests. In the abdominal strength test, data indicated similarity between both sexes, while in the remaining tests, female students exhibited higher values (Table 1).

Table 1. Initial measurement values

Indicators		Media (± DT)
Weight (Kg)	General	69 (±30)
	Male	83 (±36)
	Female	65 (±26)
Abdominal strength 30" (sec.)	General	19 (±10)
	Male	19 (±8)
	Female	18 (±10)
Arm strength (rep.)	General	16 (±8)
	Male	18 (±7)
	Female	15 (±8)

Long jump without impulse (cm)	General	142 (±43)
	Male	151 (±43)
	Female	133 (±36)
Initial pulse (p/m)	General	89 (±17)
	Male	84 (±20)
	Female	91 (±16)
Final pulse (p/m)	General	112 (±22)
	Male	110 (±26)
	Female	151 (±34)

Source: Own elaboration (2025).

Changes were observed in the final test, as although some aspects showed similar trends (weight, arm strength, and standing long jump), abdominal strength was added (Table 2).

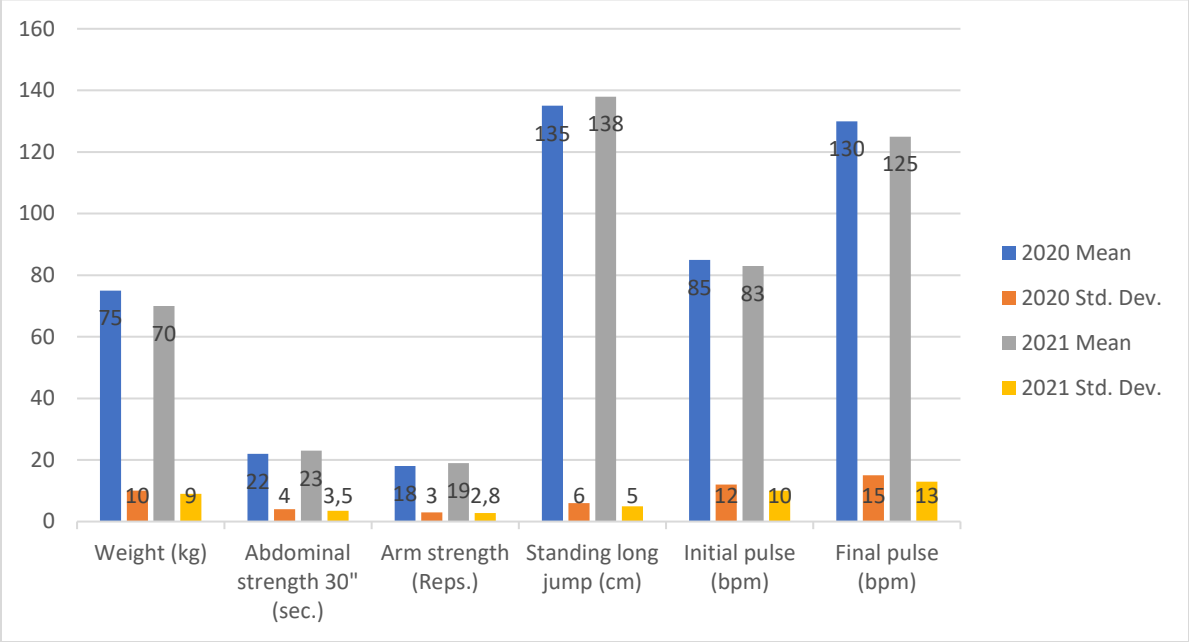
Table 2. Final measurement values.

Indicators		Media (± DT)
Weight (Kg)	General	61 (±12)
	Male	70 (±10)
	Female	58 (±11)
Abdominal strength 30" (sec.)	General	20 (±17)
	Male	23 (±17)
	Female	19 (±17)
Arm strength (rep.)	General	16 (±8)
	Male	19 (±7)
	Female	15 (±6)
Long jump without impulse (cm)	General	142 (±40)
	Male	167 (±42)
	Female	138 (±43)
Initial pulse (p/m)	General	80 (±10)
	Male	77 (±11)
	Female	81 (±10)
Final pulse (p/m)	General	100 (±13)
	Male	97 (±14)
	Female	101 (±12)

Source: Own elaboration (2025).

Comparison between the initial and final measurements showed changes in the values of each indicator. Body weight decreased, as did the initial and final pulse rates for each program session. Furthermore, there was an increase in abdominal strength results overall and by gender, arm strength results for students, and standing long jump for both genders. Another difference between the two measurements was the decrease in data dispersion in the final evaluation compared to the initial one.

The contrast between the 2020 and 2021 classes demonstrated a similar trend in initial and final states for both classes, as shown in Graph 1.



Graph No. 1. Comparison of physical performance indicators in 2020 and 2021. **Note.** Prepared by the authors based on the results obtained in the 2020 and 2021 academic years.

When processing the data obtained at the measurement moments for each gender, behaviors without significant differences were evidenced regarding the diagnostic results in the abdominal strength tests (U=911; W=3837; Z=-0.864; p=0.388), initial pulses per minute (U=768.5; W=1146; Z=-3.844; p=0.053), and final pulses per minute (U=987; W=3913; Z=-0.293; p=0.77). Similarly, in the final evaluation, there were no significant differences in pulse measurements: initial (U=773; W=1151; Z=-1.899; p=0.058) and final (U=877; W=1255.5; Z=-1.114; p=0.265).

Comparison between both courses (2020 and 2021) using the same non-parametric vertical and horizontal contrast statistics for two samples showed an initial state with statistically non-significant differences in body weight (U=1111; W=2336; Z=-1.401; p=0.161), standing long jump test (U=1242.5; W=2467.5; Z=-0.532; p=0.595), and initial pulses (U=1184; W=2669.5; Z=-0.918; p=0.358) and final pulses (U=1249; W=2474; Z=-0.489; p=0.625). In the final evaluation measurement, no statistically significant differences were found, as shown in Table 3.

Table 3. Comparisons between the 2020 and 2021 courses of results obtained in the final evaluation.

Statistics	Weight (kg)	Abdominal strength 30"	Arm strength	Long jump without impulse (cm)	Initial pulse	Final pulse
U	1155	1091.5	1056	1171.5	1197.5	1033
W	2380	2316.5	2281	2396.5	2682.5	2518
Z	-1.110	-1.533	-1.768	-1.001	-.830	-1.916
p	0.267	0.125	0.077	0.317	0.407	0.055

Note. U = Sum of ranks; W = Expected sum of ranks; Z = Z-value of the non-parametric contrast (Mann-Whitney U test); p = Significance level.
Source: Own elaboration (2025).

Horizontal comparisons through the Wilcoxon signed-rank test between the datasets obtained at moments I and II indicate the existence of changes in the data of the final evaluation compared to the reference established at the initial moment. The most significant changes from a statistical point of view were observed in body weight (Z=-3.397; p=0.001), standing long jump distance without momentum (Z=-2.462; p=0.014), and pulses recorded at the beginning (Z=-5.066; p=0.000) and end (Z=-8.6; p=0.000) of each program session.

Sex-based analysis, concerning the results presented in the previous paragraph, showed a similar behavior in female university students (Table 4) and only in weight and initial pulse in male university students (Table 5).

Table 4. Results of female students

Indicators	Female	
	Z	P
Weight (kg)	-3.230	0.001
Long jump without impulse	-2.141	0.032
Initial pulse	-4.628	0.000
final pulse	-7.367	0.000

Source: Own elaboration (2025).

Table 5. Student results

Indicators	Male	
	Z	P
Weight (kg)	-2.194	0.028
Initial pulse	-4.457	0.000

Source: Own elaboration (2025).

Those who took the course in 2020, analyzed by each course, achieved statistically similar results to those achieved by male students (Table 6), while those in 2021, unlike the rest, did not show significant changes in weight but did in abdominal strength (Table 7).

Table 6. Results of the 2020 course.

Indicators	2020	
	Z	p
Weight	-3.220	0.001
Initial pulse	-3.374	0.001
Final pulse	-6.237	0.000

Source: Own elaboration (2025).

Table 7. Results of the 2021 course.

Indicators	2021	
	Z	p
Long jump without impulse	-2.226	0.026
Initial pulse	-3.812	0.000
final pulse	-5.914	0.000
abdominal strength	-2.544	0.011

Source: Own elaboration (2025).

In each group by semester, there is a trend towards decreasing values except for pulses per minute, but in the comparisons between each measurement moment, there is a general trend towards improving the results (Table 8).

Table 8. Groups by semester

GROUPS CLASSES	INDICATORS	SEMESTER	MEDIA	DESV. TÍP.
S-II; COURSE 2020	Weight (Kg)	I	68.4815	29.23538
		II	62.2037	12.49057
	Abdominal strength (sec.)	I	20.09	10.261
		II	24.98	21.147
	Arm strength (rep.)	I	17.22	7.332
		II	18.87	8.921
	Long jump without impulse (cm)	I	139.56	44.495
		II	146.44	38.623
	Initial pulse (p/m)	I	87.63	17.981
		II	78.89	10.763
	Final pulse (p/m)	I	110.44	24.804
		II	97.20	13.750
S-I; COURSE 2021	Weight (Kg)	I	58.4764	11.97289
		II	55.5464	8.18548
	Abdominal strength (sec.)	I	13.24	5.747
		II	17.92	10.177
	Arm strength (rep.)	I	14.08	10.124
		II	15.88	6.515
	Long jump without impulse (cm)	I	131.60	36.905
		II	134.48	44.230
	Initial pulse (p/m)	I	89.36	13.961
		II	80.76	10.377
	Final pulse (p/m)	I	113.52	15.240
		II	103.24	11.523
S-II; COURSE 2021	Weight (Kg.)	I	64.3750	13.25605
		II	62.9167	11.80978
	Abdominal strength (sec.)	I	14.13	4.928
		II	15.63	6.826
	Arm strength (rep.)	I	12.67	5.122
		II	13.50	5.381
	Long jump without impulse (cm)	I	137.08	37.712
		II	146.63	45.434
	Initial pulse (p/m)	I	84.79	10.579
		II	80.71	9.910
	Final pulse (p/m)	I	112.17	20.241
		II	101.92	10.570

Source: Own elaboration (2025).

However, the differences between each group-semester were not significant, as confirmed by the results of the non-parametric vertical contrast statistic for K independent samples (Table 9).

Table 9. Comparison between groups of each semester

Indicators	Moment	x^2	p
Weight (Kg)	I	4.189	0.123
	II	5.905	0.052
Abdominal strength (sec.)	I	4.617	0.099
	II	2.352	0.309
Arm strength_I	I	5.039	0.081
Long jump without impulse (cm)	I	1.243	0.537
	II	1.896	0.388
Initial pulse (p/m)	I	1.297	0.523
	II	0.475	0.789
Final pulse (p/m)	I	0.689	0.709
	II	3.870	0.144

Source: Own elaboration (2025).

Discussion

The analysis by gender between the two measurement moments showed a decrease in the mean and standard deviation of the university students' body weight compared to female students. This trend also occurred in the results of abdominal strength for both genders, but in the opposite direction, similar to the arithmetic mean of arm strength and the standing long jump. The greatest dispersions were observed in these tests, particularly in the female gender. Regarding heart rate, there was a decrease in the final assessment, with a greater emphasis on the female gender.

These results demonstrate the effectiveness of the system of content oriented and controlled at a distance through digital platforms. The behavior of students in each course where the content system was implemented also confirms its homogeneous impact on both groups of students, as well as on the groups per semester.

From a statistical point of view, it can be inferred with 95% certainty that the content system has a determining impact on body weight and resting heart rate for both genders and courses, the distance of the standing long jump in the female gender and the students of the 2021 course, the post-recovery heart rate in the female gender and in both courses, and the number of abdominal exercises in the 2021 course, as in all these cases $p < \alpha$.

In contrast to previous studies that determined the need for time and technical support for distance education classes, and methodological work in online distance education, designing fair evaluation methods (Yu & Jee, 2021), this study works with concrete outcome indicators of physical-motor performance achieved by students through distance physical education using virtual learning platforms.

Likewise, it surpasses the study conducted by Jumareng et al. (2021), who made suggestions for the optimal development of physical education consisting of providing free internet quotas to students, motivating students, reducing frequent evaluations, and promoting offline exchanges, but like the previous research, it does not rely on the results of the teaching-learning process.

On the other hand, the data obtained coincide with those obtained in the research by Bustamante-Ara et al. (2020), as the physical activities of university students were maintained according to the distancing conditions with higher values in men, although unlike this study, the current research demonstrates that the greatest changes occurred in the female gender.

This study was developed in accordance with the findings identified by Almonacid-Fierro et al. (2021), which involved limited physical contact with students from educational institutions and the use of social networks as teaching strategies based on students' reflective and self-learning processes. A system of evaluation was achieved to verify the true learnings to which they were exposed.

In contrast to the findings identified by Flores et al. (2021), there were no significant differences in the behavior of students who took the Physical Education course in different academic years. This conclusion was reached based on the direct results obtained in the physical-motor performance achieved by the group, not solely on the perceptual criteria of those involved.

Although different variables were used, there is an assumption of correspondence between the results of the current research and those obtained by Panenggak et al. (2022) since there was a significant difference in physical activities between genders. Males had superior performance from the initial moment of the course, although the greatest transformations in each indicator occurred in the female gender, a detail not specified in the previous study.

However, this research raises some issues, such as the lack of identification of ostensible changes in general resistance tests, as only an improvement in this aspect is estimated based on the recovery capabilities evidenced in heart rate after physical activities.

Conclusions

The system of content-oriented physical activities through online modality led to an increase in students' physical-motor performance with a statistically significant impact on reducing body weight, developing explosive lower limb strength, and the recovery capacity of university students.

Conflict of interests

There is no conflict of interest.

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