



June 2023

Physical Therapy Students Experience Reductions in Physical Activity and Social Interaction During Coronavirus-Related Curricular Changes: A Cohort Study

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Recommended Citation

Flowers DW, Bernard A, McCallister E, Sant LR. Physical Therapy Students Experience Reductions in Physical Activity and Social Interaction During Coronavirus-Related Curricular Changes: A Cohort Study. *The Internet Journal of Allied Health Sciences and Practice*. 2023 Jun 29;21(3), Article 22.

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Abstract

Purpose: The Coronavirus disease 2019 (COVID-19) pandemic challenged physical therapy students and faculty. The faculty at this institution implemented a modular curriculum progressing from in-person to remote learning to parallel a predicted autumn COVID-19 surge. This study compares the effect of varying educational models on physical therapy students' physical activity and social isolation outcomes during their program's response to the COVID-19 pandemic. We hypothesized that changes in students' physical activity and social interaction would be observed throughout the semester as the curriculum became more distance based. **Methods:** This prospective cohort investigation of 42 students from a single physical therapy program was conducted from August through December of 2020. Students' physical activity [International Physical Activity Questionnaire (IPAQ)] and social isolation [Lubben Social Network Scale-6 (LSNS-6)] were assessed at four timepoints. Each timepoint included progressively less in-person interaction and more remote learning. Repeated-measures ANOVAs were performed for each measure, with associated post hoc timepoint comparisons. **Results:** Students' IPAQ scores were significantly affected by time, $F(2.54, 104.18) = 6.71, p = .001, \omega^2 = .19$, as were their scores on the LSNS-6, $F(2.48, 101.48) = 4.09, p = .013, \omega^2 = .060$. **Conclusions:** Statistical reductions in physical activity and social interactions were observed; however, on average the cohort did not drop below at-risk levels on either the IPAQ or LSNS-6. Faculty can rest assured that any curricular model will not adversely affect students; however, should be aware of the adverse effects observed in a minority of students who may be at increased risk.

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The Internet Journal of Allied Health Sciences and Practice

Dedicated to allied health professional practice and education

Vol. 21 No. 3 ISSN 1540-580X

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ABSTRACT

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Methods: This prospective cohort investigation of 42 students from a single physical therapy program was conducted from August through December of 2020. Students' physical activity [International Physical Activity Questionnaire (IPAQ)] and social isolation [Lubben Social Network Scale-6 (LSNS-6)] were assessed at four timepoints. Each timepoint included progressively less in-person interaction and more remote learning. Repeated-measures ANOVAs were performed for each measure, with associated post hoc timepoint comparisons. **Results:** Students' IPAQ scores were significantly affected by time, $F(2.54, 104.18) = 6.71, p = .001, \omega^2 = .19$, as were their scores on the LSNS-6, $F(2.48, 101.48) = 4.09, p = .013, \omega^2 = .060$. **Conclusions:** Statistical reductions in physical activity and social interactions were observed; however, on average the cohort did not drop below at-risk levels on either the IPAQ or LSNS-6. Faculty can rest assured that any curricular model will not adversely affect students; however, should be aware of the adverse effects observed in a minority of students who may be at increased risk.

Keywords: social isolation, physical activity, remote learning

INTRODUCTION

The Coronavirus disease 2019 (COVID-19) pandemic sent shockwaves through higher education worldwide. Gagnon et al. discussed how the pandemic provided the unique opportunity for physical therapy programs to implement new educational trends, specifically hybrid educational models.¹ They noted that no evidence exists on how physical therapy students may respond when their entire professional program, as opposed to a singular course, shifts to exclusive hybrid and/or online education. A predicted surge in COVID-19 infections during the typical flu season in the United States²⁻⁴ led the authors' Physical Therapy Program to alter the Fall 2020 curricular design. Our Program predicted that a resurgence of cases would reverse the gradual classroom opening of Summer 2020 and would cause courses to be transitioned to online education as in Spring 2020. Therefore, the typical 15-week fall semester was divided into three 5-week blocks, progressively moving from in-person, to hybrid, and finally to online delivery methods.

Physical therapy students' responses to alternate learning models have been explored before, during, and after the COVID-19 pandemic. In 2014, Murray et al. examined the effects of moving a single musculoskeletal course from traditional classroom format to a flipped classroom model.⁵ No differences in student outcomes were observed between the two models. Once the pandemic began and varied curricular formats were forced upon academic programs out of necessity, faculty concerned themselves with the potential impact of remote learning on students and programs. In 2021, Hyland et al. examined physical therapy and physical therapy assistant students' concerns regarding academic, nonacademic, and financial issues, as well as concerns they had regarding the transition from in-person to online learning once the pandemic hit.⁶ Students' primary nonacademic concern was their physical and mental health, while also being concerned about the loss of interaction with classmates once they moved to online coursework. These students were all enrolled in programs within the New York and New Jersey area. A similar paper by Majsak et al. in 2022 studied the concerns of faculty as they transitioned curricular formats in response to the pandemic.⁷ Among major concerns of faculty were the loss of interaction with students once online teaching was established, and the health and well-being of students. In this study the concerns regarding student health were specifically related to returning to in-person learning while the pandemic was on-going. Finally, in 2022, Neely et al. reported on the impact of virtual learning on physical therapy students as they entered the clinical component of their curricula after having gone through modified curricular formats in their didactic preparation.⁸ Thankfully, although reductions in Clinical Performance Instrument ratings were observed, no statistically significant reductions in clinical performance were observed. Our concerns centered on the physical activity and social interaction levels during curricular format modifications made in response to COVID-19, neither of which have been previously examined in physical therapy programs during the pandemic.

The authors' concerns regarding decreased physical activity were reinforced by early findings related to the pandemic. Meyer et al. showed that when examining adults living in the United States, as physical activity declined, screen time typically increased and was associated with increased stress and poor mental health.⁹ Participants who fell below activity guidelines also scored higher on anxiety and depression scales. A systematic review of the effects of the COVID-19 pandemic on students' physical activity levels noted reductions in physical activity after lockdown measures were put into place.¹⁰ However, if students had met exercise guidelines before the pandemic, they remained above the guideline levels during the pandemic lockdown despite an overall decrease in their physical activity. A study on nursing students showed increased stress, financial strain, familial problems, and less exercise in healthcare students during the pandemic.¹¹ Further, stress levels seemed to influence who passed exams. Rukowska et al. reported that physical activity levels of adult learners increased as lockdown restrictions were eased, suggesting a decrease in activity during the lockdowns.¹² Srivastav et al. reported a decrease in physical activity in a similar population to the current study, noting that this decrease in activity is especially concerning in a profession that should promote physical activity.¹³ These studies used the International Physical Activity Scale (IPAQ) to quantify physical activity.^{12,13}

Literature regarding social isolation during the lockdown was also concerning. A study in Bangladesh focused on undergraduate students during the pandemic showed that higher social connection was associated with lower stress and less depression.¹⁴ It is not clear if altered course schedules like the one proposed by this Program would result in similar changes to mental health.

Therefore, the Lubben Social Network Scale-6 (LSNS-6) was utilized throughout the semester to track social isolation in the students. The LSN-6, an abbreviated form (six questions) of the original Lubben Social Network Scale (10 questions), was originally developed to measure social isolation in geriatric populations.

Purpose and Hypotheses

Novel to this investigation is the focus on non-academic student outcomes when varied programmatic delivery methods are employed. Therefore, the purpose of this study was to determine the level of social isolation (as assessed via the LSNS-6) and level of physical activity (as assessed via the IPAQ) of physical therapy students throughout a modular, hybrid approach to instruction resulting from curricular changes during the COVID-19 crisis. Our two alternate hypotheses were that throughout the

semester, there would be changes in the levels of students' social isolation and physical activity.

MATERIALS AND METHODS

Subjects

The investigation was approved by the Louisiana State University Health Sciences Center at Shreveport Institutional Review Board, and all participants provided written informed consent. All first- and second-year students from the authors' physical therapist education program were eligible to participate in the study. Our *a priori* power analysis indicated a minimum N of 14 would be required for a repeated measures ANOVA analysis using an effect size for the IPAQ ($d = .67$).¹⁵

Outcome Measures

The IPAQ has been validated for use in a variety of populations including college-age students¹⁶ and in healthy adults.¹⁷ It has been shown to correlate well with instrumented measures of physical activity, with a stronger relationship with total exercise and vigorous exercise than with moderate/light exercise.¹⁷ One noteworthy consideration is the IPAQ's tendency to overestimate physical activity in specific populations.^{18,19}

The LSNS-6 assesses familial interaction and friendship interaction and is reliable and valid in assessing the social network of older adults,²⁰ and is reliable in college students.²¹ Recent epidemiological research has employed the use of the LSNS-6 and its associated cutoff score of 12 points in adults from the ages of 18-79 years to identify those at risk for social isolation (including in the 18-39-year-old subgroup) to make risk assessments and comparisons across age groups.²² It has also been used by multiple authors in college-aged students,^{21,23-27} including medical students in recent COVID-19-related research.²⁸

A high score on each measure indicates greater physical activity and social interaction, respectively. Scoring and processing rules for the IPAQ were followed per published guidelines.²⁹ A permission form was completed to use the LSNS-6 in this investigation. Cutoff scores have been previously established for the IPAQ (500-1,000 MET-minutes/week)³⁰ and LSNS-6 (12 points),²⁰ with scores falling below these thresholds indicating limited physical activity and social isolation, respectively.

Procedures

This observational, prospective study consisted of a repeated-measures design with an initial baseline assessment of the IPAQ and LSNS-6 at week one of the semester, followed by three post assessments. Each post-assessment was completed at the conclusion of each of the five-week intensive course blocks. Block one was traditional in-person, lab-heavy coursework in small groups. Block two was hybrid coursework, with occasional in-person labs. Block three was exclusive online education. Both the hybrid and online blocks included both synchronous and asynchronous delivery methods. Data collection was completed either using the written version of each of the questionnaires, or an adapted form transcribed into an online format. This was done due to the progressively remote/off-campus nature of the course blocks as they progressed from in-person to online. All data collection occurred from August through December of 2020. A longer study duration was not feasible given this was the only semester with the modified curriculum. Scores on the IPAQ and LSNS-6 were calculated by two of the investigators (D.F. and A.B.).

Data Analysis

Sixty-six first- and second-year students from a single physical therapist education program were recruited to participate in the study. Of those, only 42 participants completed all four assessments of the IPAQ, with a total of 34 missing data points out of 264 (12.9%). Given this high percentage, the decision was made to only include those participants who completed all four IPAQ assessments in the final data analysis ($N = 42$). Of these, there were two missing data points for the LSNS-6 (1.2%). Subgroup mean substitution was performed to fill in missing data points prior to data analysis.

The IPAQ data met all assumptions for a repeated measures ANOVA analysis, except for sphericity. Mauchly's test was significant at $p = .033$. Therefore, the conservative Greenhouse-Geisser adjustment was interpreted for overall significance of the analysis. Post hoc comparisons were performed using the conservative Bonferroni correction for each of the timepoint comparisons.

The LSNS-6 data was analyzed via parametric analysis as in previous investigations,²⁰ and met all the assumptions for the repeated measures ANOVA except for sphericity. Mauchly's test was significant at $p = .002$. As with the IPAQ data, the conservative Greenhouse-Geisser adjustment and Bonferroni corrections were used for the overall and post hoc comparisons, respectively. Data from the in-person data contained one outlier; however, after examining the data via Cook's and Mahalanobis distances, Standardized DFBeta, and Standardized DFFit, the decision was made to maintain the data point. All effect sizes for both the IPAQ and LSNS-6 analyses were expressed as omega squared (ω^2).

RESULTS

There was a total of 106 students (52 females and 19 males, with a female to male ratio of 2.74) eligible to participate in the study, including 35 first-year students (24 females and 11 males) and 36 second-year students (28 females and eight males). The female to male ratios for each of these cohorts was 2.18 and 3.50, respectively. A total of 66 students were recruited for the study, with 42 being included in data analysis. Of these, 37 were female and 5 male (female to male ratio of 2.74). This distribution matched the cohorts compared in this study. There were 21 students from each class (first- and second-year). The mean age of the participants was 23.48 years \pm 1.81, with a range of 21-32 years. Of the 24 participants who were excluded from the analysis due to not completing all four IPAQ assessments, 10 were male (42%) and 14 were female (58%), indicating minimal bias on the basis of sex with regard to inclusion in the final analysis. We performed a completer versus non-completer baseline IPAQ score comparison, testing for differences between those who completed the baseline IPAQ assessment and all three follow-ups ($N = 42$, $M = 2589.14$, $SE = 244.79$) and those who completed the IPAQ baseline assessment without all three follow-ups ($N = 17$, $M = 3075.35$, $SE = 685.45$), respectively. There was no significant difference between baseline scores in IPAQ completers and non-completers, $p = .51$. Although the completer analysis was performed based upon completion of the IPAQ at all four timepoints, we also compared baseline scores on the LSNS-6 for those who did ($N = 42$, $M = 20.55$, $SE = .63$) and did not ($N = 17$, $M = 20.18$, $SE = 1.15$) complete all four assessments of the LSNS-6. There was no significant difference between baselines scores in LSNS-6 completers and non-completers, $p = .75$.

The outcomes across all four timepoints are recorded in Table 1. The overall repeated measures ANOVA for the IPAQ analysis indicated scores (MET-min/week) were significantly influenced by time of assessment, $F(2.54, 104.18) = 6.71$, $p = .001$, $\omega^2 = .19$. Post hoc analyses for the IPAQ analysis are provided in Table 2. Figure 1 shows the IPAQ scores over time. The overall repeated measures ANOVA for the LSNS-6 analysis indicated scores were significantly affected by time of assessment, $F(2.48, 101.48) = 4.09$, $p = .013$, $\omega^2 = .060$. Post hoc analyses of the LSNS-6 analyses are provided in Table 3. Figure 2 shows the changes in LSNS-6 scores over time. Figures 3 and 4 show the individual scores of all participants across all four timepoints on the IPAQ and LSNS-6, respectively, each denoting the cutoff scores established for each measure. Figure 4 provides a violin plot which demonstrates the overlap of scores amongst participants given the narrow score range of the LSNS-6. Boarder shaded regions indicate greater numbers of participants at given scores, while narrower regions indicate less overlap in scores.

Table 1. Scores on the International Physical Activity Scale and Lubben Social Network Scale-6 Over Time^a

	Baseline	In-Person	Hybrid	Online
IPAQ ^b	2589.14 (1596.40)	1745.62 (1323.75)	1992.18 (1520.42)	1704.00 (1761.00)
LSNS-6	20.55 (4.07)	19.74 (5.08)	19.10 (4.46)	19.02 (4.14)

Abbreviations: IPAQ, International Physical Activity Scale, LSNS-6, Lubben Social Network Scale-6.

^a Values provided are mean (standard deviation).

^b Units are MET-minutes/week.

Table 2. Post Hoc Comparisons of the International Physical Activity Scale Data

Timepoint Comparison	Mean Difference (Standard Error)	p -value (95% CI)
Baseline to In-Person	-843.52 (205.66)	0.001 (273.36, 1413.69) ^a
Baseline to Hybrid	-596.96 (209.72)	0.041 (15.56, 1178.37) ^a
Baseline to Online	-885.14 (259.85)	0.009 (164.75, 1605.54) ^a
In-Person to Hybrid	246.56 (164.71)	0.852 (-703.18, 210.06)
In-Person to Online	-41.62 (259.36)	1.00 (-677.42, 760.65)
Hybrid to Online	-288.18 (222.36)	1.00 (-328.29, 904.65)

^a Significant at alpha = .05.

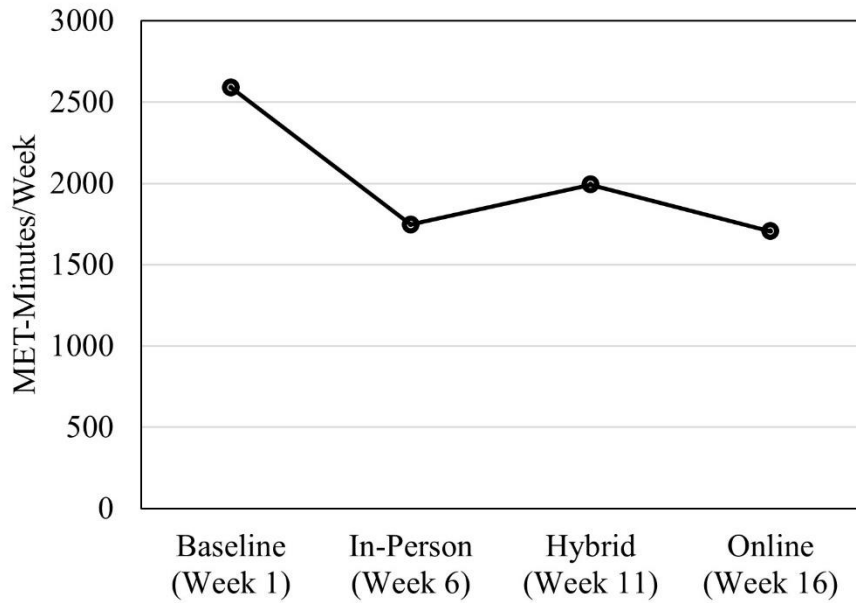


Figure 1. IPAQ Scores Over Time

Table 3. Post Hoc Comparisons of the Lubben Social Network Scale-6 Data

Timepoint Comparison	Mean Difference (Standard Error)	p-value (95% CI)
Baseline to In-Person	-.81 (.58)	1.00 (-.80, 2.42)
Baseline to Hybrid	-1.45 (.49)	0.034 (.089, 2.82) ^a
Baseline to Online	-1.52 (.50)	0.024 (.14, 2.91)
In-Person to Hybrid	-.64 (.48)	1.00 (-.68, 1.96)
In-Person to Online	-.71 (.56)	1.00 (-.85, 2.27)
Hybrid to Online	-.071 (.319)	1.00 (-.81, .96)

^a Significant at alpha .05.

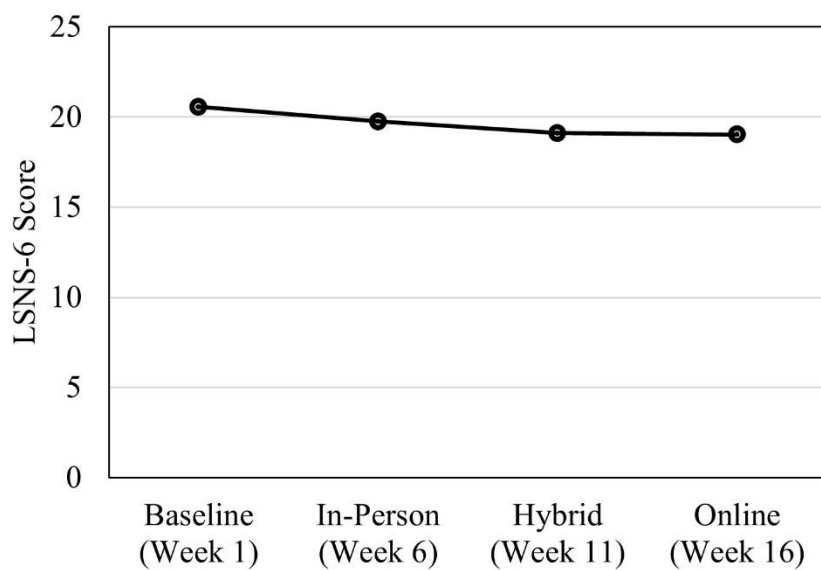


Figure 2. Changes in LSNS Scores Over Time

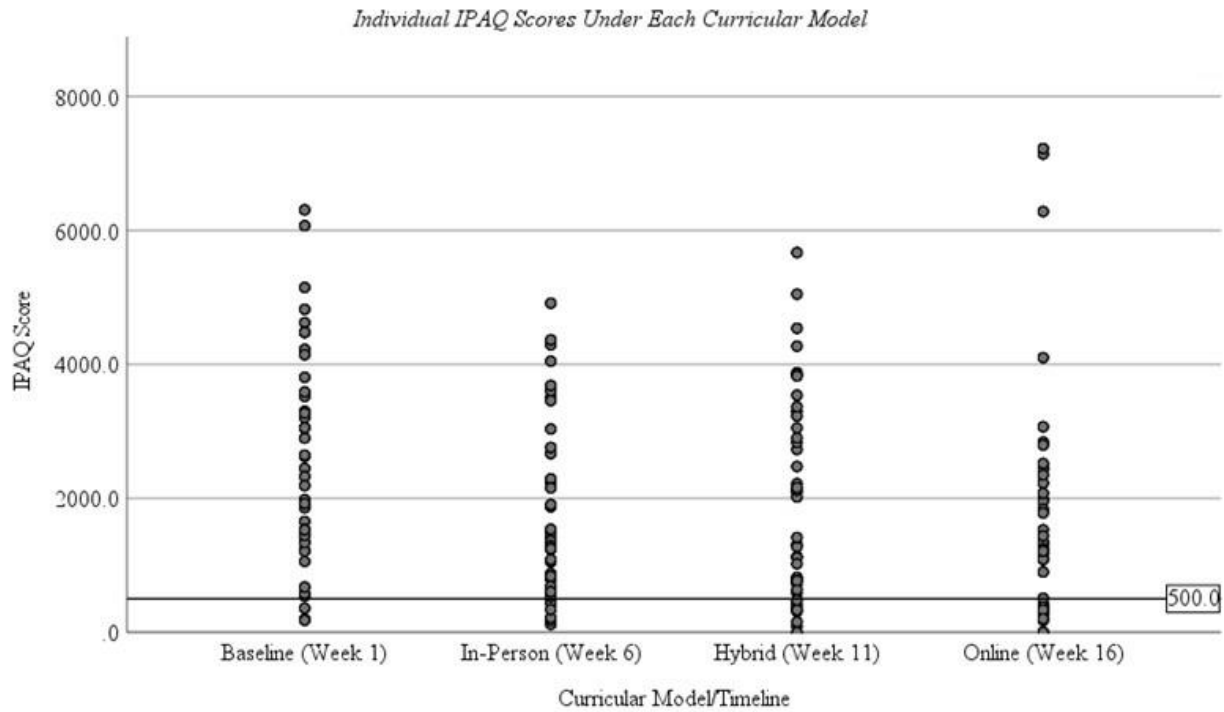


Figure 3. Individual IPAQ Scores Under Each Curricular Model

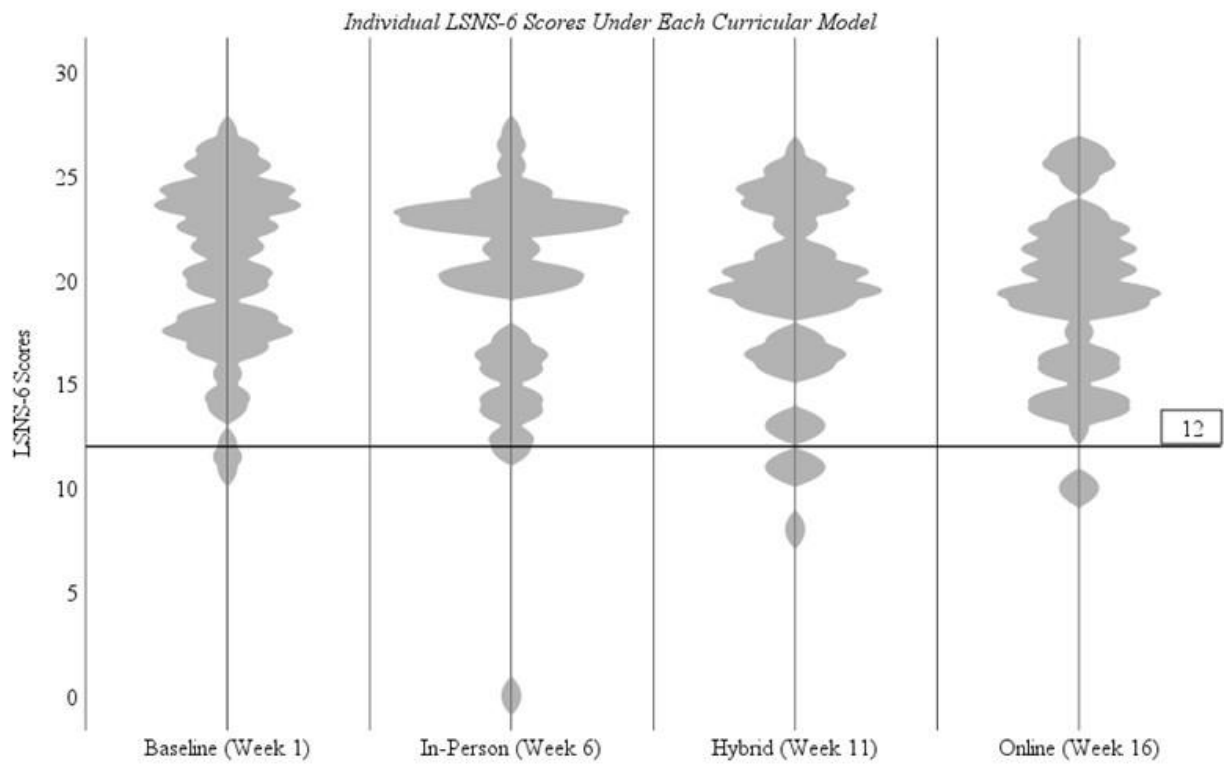


Figure 4. Individual LSNS-6 Scores Under Each Curricular Model

Despite statistical reductions in physical activity, the average score reached the recommended 500-1,000 MET-minutes/week. Post-hoc comparisons indicated a significant reduction in social interaction scores between baseline and post-hybrid education (p

= .034) and baseline to post-online education ($p = .024$) assessments (Table 3), although the average score decreased only from 20.55 at baseline, and 19.10 and 19.02 for post-hybrid and -online assessments, respectively (Table 1). Mean scores at all time points remained above the 12-point cutoff that indicates high levels of social isolation.²⁰ The total percentage of data points below these cutoffs (see Figures 3 and 4) across *all* timepoints was 18.5% for the IPAQ and 4/8% for the LSNS-6. Students were least active when their courses were completely online, with 33.3% of the students falling below the IPAQ cutoff during this single timepoint.

DISCUSSION

DPT students experienced simultaneous reductions in overall social interaction and physical activity while progressing through the modified curriculum (i.e., from baseline, to in-person, hybrid, and finally to online). There were no statistical differences in physical activity between any of the educational models used during each timepoint on the IPAQ, except when comparing each timepoint to baseline. The same held true with the LSNS-6 data, but with no significant difference noted between baseline and the in-person learning block. These findings suggest that the onset of a semester's workload, regardless of what method of delivery is used in instructional design, accounts for at least a portion of the reduction in physical activity observed in physical therapy students. However, the reduction in social interaction is not observed until in-person learning is ceased. Given the study design, it was not possible to completely isolate the effects of instructional design from the normal effects of a semester.

Therefore, the physical activity levels of physical therapy students are not impacted by how students learn, but by their enrollment. Additionally, physical therapy students' social interaction is somewhat dependent upon the availability of in-person learning but does not place them at high-risk for social isolation. There appears to be no difference between hybrid and online learning regarding students' social interaction levels.

Since students are a vulnerable population, special consideration should be given to the participants whose scores fell below the associated cutoffs. Faculty can follow previous recommendations and recent evidence to guide these at-risk students through hybrid models by promoting organizational skills, self-management techniques, independent learning strategies, and help-seeking behaviors.³¹ Van Veld et al. encourage faculty of DPT programs to discuss with students actions they can take to cope with their new learning environment, including exercise.³² One survey of pharmacy colleges showed that counseling, academic advising, and exercise classes are being offered in 95%, 82.5% and 77.5% of programs, respectively.³³ Interestingly, recent research shows group exercise is related to decreased anxiety in undergraduates³⁴ and improves quality of life in medical students.³⁵ In each of these studies, independent exercise did not have the same positive association³⁴ or benefit.³⁵ Considering our findings of synchronous decreases in physical activity and social interaction, group exercise could serve as a mitigant.

Gagnon et al. stress the importance of social presence as a key consideration in designing hybrid learning.¹ They call for DPT programs to design learning experiences that facilitate social interaction and community by incorporating methods such as synchronous discussions and video chats. Jones et al. found that students enrolled in healthcare professional programs reported greater satisfaction with their connection to other students via an online interprofessional education experience as compared to meeting in-person.³⁶ While most of our cohort maintained an acceptable level of social interaction, it is the students who fall below who are of most concern. These interactive teaching methods promote social presence of learning and allow educators to closely monitor at-risk students.

Determining how students may respond to a "triggering event" is important for academic faculty. Although our study's focus was on students' ability to cope with changes resulting from a pandemic, Ellison et al. surveyed DPT students one semester following a hurricane event.³⁷ Hurricanes and pandemics both have long-lasting effects; however, the COVID-19 pandemic potentially has greater impact on mortality, mental health, community support, access to healthcare, and life stresses, all of which require long-term amelioration.³⁸ Despite differences in measurement constructs and time since the triggering event, the students' responses were similar in both studies. Ellison et al. found that 19.0% and 5.2% of the students included in their study did not engage in any strengthening or aerobic activity, respectively, noting that these terms were not all-inclusive of all exercise modalities.³⁷ As our students had a total of 18.5% data points below the cutoff for the IPAQ across all timepoints, our overall findings mirrored those of Ellison et al.³⁷ However, when a one-time assessment of the most inactive portion of the semester is considered, our students fared much worse, with 33.3% of the students falling below the activity threshold during online education. The students in the Ellison study were shown to have lower levels of anxiety and depression when compared to other graduate students; however, suicidal thoughts were just as frequent.³⁷ Therefore, even though our study did not measure depressive symptoms, faculty may consider the Ellison et al.³⁷ findings when altering the curriculum in a way that decreases social interaction and/or exercise. Special attention should be given during times of entirely remote learning, as this seemed to exacerbate physical inactivity in the current study.

A reduction in physical activity appears to be a normal aspect of the student experience in physical therapy school. Under normal conditions, first-year physical therapy students experience decreased cardiovascular endurance after the first year of school.³⁹ Students also report significantly less activity on exercise logs during the fall semester as compared to summer and winter semesters. Our study used different dependent variables so no direct comparison to the above findings can be made; however, our findings indicate a similar trend in decreased physical activity after semester start. This reduction in physical activity was not dependent on the curricular model employed as mentioned above.

Therefore, our results present three main findings. First, most students did not have negative physical activity or social effects resulting from modular curricular changes progressing from in-person to remote learning. Second, a small number of students are at risk for the negative physical activity and socialization effects not observed in many students. Of note, this small number of students with decreased physical activity increased as the blocks moved toward more remote learning. Third, faculty should exercise caution and prudence before recycling pandemic-era teaching methodologies out of convenience, with an honest assessment of whether they are truly better and conducive to students' learning.

LIMITATIONS

This investigation included students from a single physical therapist education program since the curricular changes were the program's unique response to the COVID-19 pandemic, making a multi-institutional design not feasible, limiting generalizability of the results. Another limitation is the number of participants whose data was not able to be included in the analysis given the large percentage of missing data points. Regardless, the study was able to achieve adequate statistical power by exceeding the required *N* per the *a priori* power analysis. Additionally, baseline scores for completers and non-completers for both the IPAQ and LSNS-6 were equivocal, making our use of completer analysis more robust. Methodologically, there were possible uncontrolled covariates present (e.g., student-specific experiences during the pandemic, extracurricular obligations, etc.) not collected and analyzed. This was to prevent further burdening the students with extraneous data collection. The LSNS-6 not being specifically validated in the physical therapy student population is also a limitation; however, it has been used in the young adult and college student populations. Finally, due to progressively more distance-based, online format of the coursework throughout the study, completion of the IPAQ and LSNS-6 transitioned from being completed on paper, to being completed on an online format. The authors are unable to rule out any influence this may have had on the results.

CONCLUSION

The blocked curriculum design coincided with statistically negative changes in physical therapy students' self-reported levels of physical activity and social interaction; however, these changes were not clinically meaningful and occurred primarily at onset of the semester. Physical activity levels are impacted by onset of the semester workload, while social interaction was impacted by the onset of hybrid/online learning curricular changes. Faculty should consider these findings when responding to future threats, and when considering retaining changes made during the pandemic once social distancing measures are relaxed. Whether this curricular design added to the effects of the COVID-19 pandemic on social interaction or had a more direct causative effect is a possible avenue for future research.

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