


**Research Article**

## The Effects of the HyFlex Learning Model on Undergraduate College Student Activity Levels

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### Abstract

This study represents a new line of research focused on the potential effects of a hybrid learning model on established health predictors (sleep and activity level) during the COVID-19 pandemic. This research explored the correlation between the mode of education delivery (online vs. in-person classes) to the students' sleep duration and activity level. Current literature supports the paradigm that lower physical activity leads to negative health outcomes. At the time of this writing, there was a lack of scientific knowledge on the pandemic-produced ratio of online courses taken per day and face-to-face classes taken per day and how those differences may affect sleep duration and activity levels of college students. The results of this study showed an inversely correlated relationship between the utilization of a HyFlex (online and in-person delivery mode) learning model and students' activity level. For each additional online class, a student took in a given day (when compared to the same student going to in-person classes) the amount of mild activity decreased by nearly 7 minutes ( $b = -.115$ ,  $p < .001$ ). This research also found that taking online classes had the same effect on vigorous activity levels, decreasing the time spent in activity by 2.1 minutes for each online course taken on any given day ( $b = -.035$ ,  $p = .020$ ). This relationship between online learning and activity level is important in understanding the potential negative effects on physical health for college students as educators try to deliver a robust learning experience via online education both during and after the COVID-19 pandemic.

**Keywords:** HyFlex, Learning, Online, Activity, COVID, Undergraduate Statements and Declarations

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### Introduction

#### Background

Starting in the spring of 2020, around the United States, and the world, college and university leadership teams were immersed in high-stakes discussions in response to the COVID-19 pandemic. Under the guidelines from state and federal health officials, public and private institutions were required to have an educational delivery system in place, which fostered compliance for, and allowed, adherence to social distancing between people at all times, even while wearing a facial covering.

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For the Fall of 2020, Davidson College surveyed 1,442 four-year universities about their reopening plans for the Fall semester (2020). Of the schools surveyed, 7% had plans for a fully online semester, 22% had plans for a hybrid semester, and only 3% had plans for a fully in-person semester. While some schools chose to deliver their education fully online in the Fall of 2020, other schools chose to use the HyFlex model [1]. The HyFlex model is an instructional approach that combines face-to-face and online learning. Each class session and learning activity is offered in-person, synchronously online, and recorded for asynchronous online learning. Universities who adopted the HyFlex model allowed students to decide how they would like to participate, yet little is known as to how their choice will affect their students' learning, health, and wellbeing.

One study done at York College of Pennsylvania surveyed their students in two courses that underwent the HyFlex model of learning. Students favored in-class problem solving and in-class instruction as opposed to online Zoom instruction and extra Zoom sessions outside of class times. However, the HyFlex model provided students with attendance flexibility and increased accessibility. Students also preferred having the option to still interact with instructors and classmates face-to-face and keep the hands-on aspect of learning if they so choose [2]. Inherent in the HyFlex model of learning is more time spent online doing schoolwork as opposed to the traditional in-person models of learning, pre-pandemic. Increased screen time has been associated with a decrease in physical activity and has also been associated with obesity risk factors for many adolescents and youth [3]. A study regarding screen time and health among children discussed the physical and psychosocial health outcomes associated with an increase in screen time and sedentary activity. There is considerable evidence that higher levels of screen time are associated with a variety of health harms, with evidence strongest for adiposity, unhealthy diet, depressive symptoms, and quality of life [4]. In addition, online learning has been associated with negative cognitive and physical health [5].

Daily physical activity is extremely important for college-aged students to live a healthy and balanced lifestyle. Results from a 2013 study indicate that meeting the current moderate to vigorous physical activity (MVPA) recommendation was positively associated with several protective factors among college students, including adequate daily fruit and vegetable consumption, positive perception of general health status, healthy BMI, consistent seatbelt use, not smoking cigarettes, less perceived depression, and adequate sleep most days of the week. Results of this study also indicate that meeting the current MVPA recommendation was also associated with a decrease in health risk behaviors, including binge drinking, physical fighting, and having multiple sexual partners [6]. Physical activity has also been associated with positive mental

health benefits in many college-aged students. Another 2013 study found that students experienced a decrease in depression and anxiety symptoms in association with an increase in their physical activity [7].

There have been various instances in which physical exercise has greatly enhanced learning opportunities by improving brain function for elementary school students, adolescents, and the elderly. In elementary school students in which playground lessons with associated exercise lessons were utilized prior to learning mathematical timetables, there was a significant increase in scores than students who were classroom bound. As compared to the students who were in the classroom, the students on the playground had on average 1,848 more steps. Improved learning can be attributed to exercise that induces positive changes in neural pathways and other adaptations in the brain [8]. In adolescents, the release of brain-derived neurotrophic factor (BDNF) was found to positively improve memory; as physical exercise becomes more vigorous, BDNF levels increase, improving learning and memory even more-so [9].

In a systematic review of ten studies investigating changes in physical activity levels amongst university students, nine out of the ten studies found a significant decrease in physical activity levels during lockdowns, each with varying increases and decreases for mild, moderate, and vigorous physical activity [10]. Only one study found an increase in all measured categories (moderate, vigorous and total physical activity) [11].

This study investigated Health science students specifically, where health science students were found to have high levels of total physical activity [11]. Most of the ten studies were completed in 2020, specifically late March, April and May, near the beginning of COVID-19 lockdowns and university closures. Comparing pre-lockdown activity levels to activity levels early in the pandemic during state and national lockdowns/campus closures lends insight to change in activity levels as lockdowns and restrictions changed throughout the pandemic. Some significant results include walking minutes decreasing anywhere from 32.5% to 365.5% when comparing pre-pandemic and lockdown activity levels [10]. When looking at all ten studies, mild physical activity decreased about 32.5%, moderate physical activity decreased anywhere from 7.9% to 59.7%, vigorous physical activity decreased anywhere from 2.9% to 52.8%, and total physical activity decreased anywhere from 28.6% to 50% compared to pre-pandemic physical activity levels of university students.

For many institutions, the student learning experience and perceived safety provided by a reopening plan could have a profound and lasting effect on the success of universities. Higher educational institutions have options: offer online courses to students who remain outside of the university

campus, offer online courses for students who are living on-campus, offer face-to-face course instruction within the guidelines of social distancing, or offer a mixture of both online and face-to-face courses as well as a choice to learn remotely or live on-campus. Each approach has its limitations when compared to the traditional learning environments often utilized before the response to the COVID-19 pandemic. Increased time spent in front of a light-emitting screen while learning online may affect the physical activity levels, as well as sleep duration, of students. Many universities have turned to the HyFlex, or hybrid flexible, model for curriculum delivery as a means of providing educational opportunities while adhering to the new official health guidelines and meeting learning objectives.

### Purpose and Goals

The purpose of this study was to explore the effect of the HyFlex online learning format on student activity and sleep. Given the prevalence of hybrid nature of learning as a result of the COVID-19 pandemic, less in-person class time and, therefore, more time spent online were the primary reasons for studying college student activity levels. Potential correlations concerning the HyFlex model and daily life functions (sleep, physical activity, and screen time) were investigated by collecting data on the amount of sleep, amount of in-person versus online courses, and time spent performing mild, moderate, and/or vigorous physical activity each day.

The goal of study was to gain a better understanding of student activity and sleep while participating in the HyFlex model of learning and how engaging in classes (online vs. in-person) impacted these daily wellness factors. Before the pandemic, full-time students attended classes in person nearly every day, and even simple actions such as walking to classes contributed to positive daily activity levels of students. During the pandemic, students are primarily unable to attend all their classes and meetings in person, students were also encouraged by university, state, and federal officials to stay in their living spaces to attend class online. This may potentially decrease activity levels, in multiple ways, as students are more likely to be sedentary while attending online classes.

Another factor to be considered when analyzing the current student activity level in the HyFlex model of learning was that gyms and exercise classes have significantly reduced their capacity. Before social distancing requirements, a student would be able to go to the gym or exercise in a public space during their free time, if they so choose. Now, reduced capacities, social distancing, and mask requirements are all factors that may have deterred a student from wishing to engage in physical activity. Furthermore, considering the multitude of changes to educational, social, physical, and emotional aspects of life due to the ongoing COVID-19 pandemic there are possible deviations from previously researched normal levels of student activity and sleep. Our

research aims to provide insight on possible influences within the Hy-Flex learning model on a student's daily life.

### Significance

Inherent in the HyFlex model is an increase in screen time devoted to online learning requirements; however, there have been growing concerns about the impact of screens on people's health [3]. The proliferation of electronic devices such as computers and cellphones are salient in the poor sleep of users. The use of the screen-based activities, such as participating in the HyFlex model, the light given off by the screen, and the material on the screen all contribute to a change in sleep patterns. Evidence suggests that increasing night-time use of computers is associated with a decrease in sleep duration and later sleep onset [4, 5].

Moreover, increased online learning may lead to an increase in sedentary time. The HyFlex model, in collaboration with social distancing and other public health measures, encourages students to remain in their homes to complete their coursework and virtually attend classes. Recent evidence links sedentary behavior with poorer health outcomes, since many adults accumulate the majority of their daily sitting time through their occupation, much like accumulated sitting time through online learning [6].

Overall, to our knowledge, research has not been completed with regards to the new HyFlex model and how it affects the college-aged population. In addition, the proposed research focused on two aspects of health, physical activity and sleep hygiene, and how they relate to the implementation of more online classes. The potential ability to compare physical activity and sleep of subjects involved in the HyFlex model to those at universities with other models of education could lead to an insight on the generalizability of these health predictors concerning online education models. Furthermore, information gathered from this research could potentially support the justification for additional research to explore the HyFlex model in this new post-COVID generation.

### Procedure

#### Methods of Recruitment

Recruitment for the study was not randomized. Recruitment relied upon social networking, an email distributed to the students enrolled in Quinnipiac University's School of Health Sciences, and a PowerPoint slide sent to professors within the school as a means of promotion. The email and PowerPoint slide contained a QR code to scan for students who were interested in volunteering for the study. If a student wanted to learn more, they were able to contact one of the student researchers to begin the process of informed consent. After contacting the research team, students who sent back the Informed Consent were given one of two start dates.

## Informed Consent

The QR code used for recruitment directed students to a survey that they filled out with their name and email to receive the informed consent. Students received an email with the informed consent and were made aware that they could terminate participation at any time throughout the duration of the study. The students had the opportunity to ask questions regarding the informed consent and were reminded that it is completely voluntary to participate.

## Data Collection

Data from this project was collected by a daily survey that was sent to the participants to fill out every night around 9:00 pm. This survey acted as their self-report and included questions regarding sleep duration, the length of exercise they did during the day, and how many online or on-ground classes they had that day (Appendix A). The self-reported survey was sent and collected electronically every day of the trial to maintain a safe distance.

## Characteristics of Population

The targeted population included full-time Quinnipiac University students between the ages of 18 and 30 participating in the HyFlex model of learning. Subjects were excluded if they chose to learn entirely remotely or if they had a physical condition that would inhibit the subject's ability to ambulate. Subjects requiring assistive devices for safe functional mobility were excluded from the study.

## Data Analysis

To assess the effect of the number of online classes and number of on-ground classes a student takes on the amount of vigorous, moderate, and mild activity a student engages in on that day, a linear mixed model analysis was used. To account for the correlation of the 14 days of survey data within each student the intercept varied randomly by student. The number of online and on-ground classes were partitioned into a between students' component, which tested if the average number of classes across all days affected activity level, and a within student component, which tested if having more or

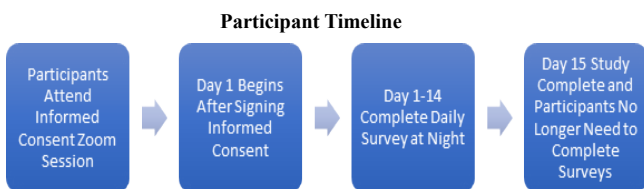
less number of classes on a particular day than usual affected activity level. In addition, a variable indicating a weekend day was included in the model. Analyses were conducted in SPSS v27 and statistical significance was set at an alpha level of .05.

## Results

Table 1 shows the descriptive statistics of the 85 students who participated in the study. Participation was very good, on average students filled out the survey on 13.1 (94%) of the possible 14 days. During the weekdays the students had on average 0.7 on-ground classes and 1.3 online classes. Students spent an average of 6 hours on screen time and slept 6.9 hours. Students spent 1.4 hours per day engaging in mild activity, 0.4 hours in moderate activity and just 0.2 hours in vigorous activity.

Table 2 presents the results from three linear mixed model analyses of each activity level. Students spent significantly less time engaged in vigorous activity during the weekends ( $b = -.123, p < .001$ ). Compared to weekdays students were about 7.4 ( $-.123 * 60$ ) minutes less vigorously active on the weekends. The number of on-ground classes did not affect vigorous activity level but there was a significant effect for within online class ( $b = -.035, p = .020$ ). For each additional online class taken on a particular day the time spent in vigorous activity that day decreased by 2.1 minutes. For moderate activity, neither the number of on-ground or online classes was predictive, but students were less moderately active on weekends ( $b = -.100, p = .050$ ) by six minutes. The amount of time engaged in mild activity was also less on the weekend ( $b = -.143, p = .049$ ). Similar to vigorous activity, the number of on-ground classes did not affect mild activity levels, but online within classes did ( $b = -.115, p < .001$ ). For each additional online class for a given day the amount of mild activity decreased by nearly seven minutes.

The number of hours slept was not significantly affected by weekend, number of on-ground classes, or number of online classes (not shown). Further, screen time was not



**Figure 1:** Timeline for individual participants in study. Each participant interested in completing the study attended a Zoom session to receive the informed consent. If the participant signed the informed consent and agreed to completing the study, they received a survey to complete that night marking day 1. For 14 consecutive days, participants would complete a daily survey at night.

**Table 1:** Descriptive Statistics (n=85)

	Mean	SD	Min – Max
Number Days	13.1	2.3	3 – 14
On-ground Class Number	0.7	0.5	0.0 – 2.0
Online Class Number	1.3	0.6	0.0 – 2.9
Screen Time Hours	6	2.1	2.4 – 13.4
Sleep Hours	6.9	0.9	4.5 – 9.4
Mild Activity Hours	1.4	1	0.1 – 5.6
Moderate Activity Hours	0.4	0.3	0.0 – 1.3
Vigorous Activity Hours	0.2	0.4	0.0 – 2.6

**Table 2:** Mixed Models Analysis Results

Outcome	Vigorous		Moderate		Mild	
	Coefficient (SE)	P-Value	Coefficient (SE)	P-Value	Coefficient (SE)	P-Value
<b>On-ground class</b>						
<b>Between</b>	.046 (.139)	0.742	-.120 (.108)	0.268	-.079 (.338)	0.815
<b>Within</b>	-.008 (.015)	0.601	.001 (.025)	0.967	-.004 (.036)	0.916
<b>Online class</b>						
<b>Between</b>	.092 (.116)	0.795	.100 (.089)	0.267	.064 (.822)	0.267
<b>Within</b>	-.035 (.015)	0.02	-.020 (.024)	0.412	-.115 (.034)	<.001

predictive of activity level, even though the number of online classes for a day was predictive of screen time that day (not shown;  $b=.686, p<.001$ ).

## Discussion

The results of this study showed an inversely correlated relationship between the utilization of a HyFlex (online and in-person delivery mode) learning model and students' activity level. For each student, the more online classes that student had in a day, the less mild and vigorous activity they participated in (Table 2). Mild activity can be described as walking, leisure biking, and light calisthenics; while vigorous activity is defined as high intensity interval training (HIIT), sprinting, or playing a competitive sport. This effect was seen at the individual level (within effects), where students reported different levels of activity in relation to the number of online classes taken for that day. The number of online classes taken by each student had a direct negative relationship with activity level for that student. When looking at an individual student's schedule, the days where they attended more classes online were associated with a decrease in both vigorous and mild activity. On the days where students had more online classes, the activity levels were comparatively lower to days where students had less online classes. One possible explanation for this finding is that more time spent taking classes online may encourage a more sedentary disposition. Another possible explanation for a decrease in mild activity may be attributed to the removal of the need to walk to and from on-ground classes.

This finding is important because the opportunity for increased screen-time becomes more prevalent as education delivery shifts online, especially with the response to the COVID-19 pandemic (Gallagher and Palmer 2020). Students in an online learning environment not only have screen-time for class instruction but also with online assignments, group projects, readings, and exams. The inverse relationship found between number of online classes and activity level is concerning for the overall health of our student-aged population and should give educators pause. It has been found that 2 hours and 30 minutes of moderate activity performed weekly will increase school performance as well

as lead to better physical and mental health outcomes [12]. For each additional online class for a given day the amount of mild activity decreased by nearly seven minutes. Mild activity in particular, such as walking, has been shown to have numerous health benefits, both physically and psychologically. Physically, mild activity can influence weight control, increase bone strength in weight-bearing activities, and increase muscle strength [13]. In terms of mental health, mild physical activity such as walking has been found to reduce stress and feelings of depression, and increase positive emotions [14]. As the COVID-19 pandemic has shifted learning opportunities more towards online and hybrid learning models, educators must evaluate the overall effects these methods take on their students' health and wellbeing.

## Limitations

Self-reported surveys are limited in validity in that they are dependent on reliability [15]. It may be difficult for students to remember the exact length of time they spent doing each activity by the end of the day. This could lead to a discrepancy in the actual time and the reported time in the survey results.

## Future Directions

In order to further study the effects of online class on physical activity, activity trackers can be used to calculate steps walked, time in activity, and calories burned. These activity trackers can give a more in-depth look into how hybrid learning effects the physical patterns of students on a day-to-day basis.

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### Supplementary Figure A: Daily Survey

**Please state your full name:**

Participant typed out their full name here

**Please state the date:**

Participant typed out the date here

**How much sleep did you get in the past 24 hours?**

Choose from: None to 12 or more hours.

**How many on-ground classes did you have today?**

Choose from: None to 5 classes.

**How many online classes did you have?**

Choose from: None to 5 classes.

**How much screen time would you estimate you had today? This includes classes, meetings, social media, etc.**

Choose from: None to 20 hours.

**How much time did you spend doing a mild activity? This includes activities like walking, cooking, etc.**

Choose from: None to 6 or more hours (30-minute intervals).

**How much time did you spend doing a moderate activity? This includes activities like weightlifting, moderate workouts, hiking, etc.**

Choose from: None to 5 or more hours (30-minute intervals).

**How much time did you spend doing a vigorous activity? This includes activities like running on a treadmill, HIIT (High Intensity Interval Training) workouts, drills for sports practice, etc.**

Choose from: None to 5 or more hours (30-minute intervals).