

# Tracking physical activity in baccalaureate nursing students in the United States prior to graduation: A longitudinal study

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## ABSTRACT

**Objective:** To evaluate changes in physical activity among baccalaureate nursing students over time.

**Design:** Longitudinal descriptive study.

**Setting:** Baccalaureate nursing program at a four-year university in the United States.

**Participants:** Fifty-two male (n = 4) and female (n = 48) nursing students.

**Methods:** At the beginning and end (weeks 1–2 and 15–16) of the three semesters prior to graduation, students completed the International Physical Activity Questionnaire (IPAQ) and their body mass index (BMI) was calculated. Based on the IPAQ, physical activity was calculated as MET-minutes per week of vigorous, moderate, and walking activities, using metabolic equivalents of 8.0 METS for vigorous, 4.0 METS for moderate, and 3.3 METS for walking.

**Results:** At baseline, students were  $21.3 \pm 1.4$  years old with a BMI of  $23.5 \pm 2.9$  kg/m<sup>2</sup>. BMI increased throughout the study and prior to graduation was  $23.9 \pm 3.2$  kg/m<sup>2</sup> ( $p = 0.039$ ). Overall, students maintained high physical activity levels that did not change statistically. Walking was the predominant activity, followed by vigorous and then moderate activity. Walking and vigorous activity displayed opposing patterns. Vigorous activity decreased over the first three measurement periods ( $p = 0.029$ ), increased for the fourth period, and then decreased again over the last two periods ( $p = 0.037$  compared to baseline). By comparison, walking increased over the first three measurements ( $p = 0.002$ ) and then decreased again ( $p = 0.015$ ). When students were grouped by physical activity level (moderate vs. high), there were significant between-group differences in vigorous activity and walking. At baseline and end of study, the moderate activity group participated in 58% and 49% less vigorous activity, and 83% and 45% less walking than the high activity group.

**Conclusion:** In this group of baccalaureate nursing students, overall physical activity did not decline with time. Students participated in sufficient physical activity to promote health, and after graduation, they are likely to provide effective patient counselling regarding healthy lifestyles.

## 1. Introduction

Regular physical activity and a healthy body weight have multiple benefits, including decreased risk for onset of chronic disease (Aune et al., 2015; Kyu et al., 2016; Rebar et al., 2015), decreased mortality (Lahart et al., 2015; Micalos et al., 2017), and reduced health care expenditures (Carlson et al., 2015). Furthermore, evidence supports an interaction between physical activity and weight control, such that engagement in regular exercise promotes both weight loss and weight maintenance over time (Dashti et al., 2014; Dombrowski et al., 2014; Johns et al., 2014). Health education can increase physical activity and exercise adherence among generally healthy adults (Orrow et al., 2012), and those with heart disease (Uysal and Ozcan, 2015; Zhu et al.,

2013) or type 2 diabetes (Dasgupta et al., 2017). Hence, patient education regarding the benefits of physical activity is an appropriate component of nursing practice that, in the United States, aligns with Essential VII for baccalaureate nursing education (American Association of Colleges of Nursing, 2008).

Although effective physical activity counselling can be both brief and minimally burdensome (Orrow et al., 2012), it is not provided consistently by physicians (Gabrys et al., 2015; Pojednic et al., 2017). Professional nurses are in an ideal position to provide patient education, and although research is limited, nurse-driven education can be effective in changing patient behaviors (Mathew and Thukha, 2017). Available evidence from the United States and Canada indicates that healthcare providers who are more physically active and maintain a

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healthy body weight are more likely to provide patient education (Bleich et al., 2014; Bleich et al., 2012; Esposito and Fitzpatrick, 2011; Frank et al., 2003; Frank et al., 2010; Frank et al., 2008; Howe et al., 2010; Lobelo et al., 2009). Unfortunately, nursing students are less likely than other disciplines, such as medical students, to participate in regular physical activity (Blake et al., 2017; Haddad et al., 2004; Micalos et al., 2017) and 25–50% have been found to be sedentary (Deasy et al., 2016; Irazusta et al., 2006; Lehmann et al., 2014). Furthermore, gender differences in self-reported activity patterns have been observed, with male students reporting greater levels of physical activity than female students (Al-Kandari and Vidal, 2007; Burke and McCarthy, 2011; Chan, 2014). Previous research regarding physical activity among baccalaureate nursing students has been primarily cross-sectional with only one-time measurement. Although informative, there are limitations inherent in a cross-sectional design. Longitudinal studies are needed to better understand changes in physical activity among nursing students. Therefore, the purpose of this study was to evaluate changes in physical activity in baccalaureate nursing students over time prior to graduation.

## 2. Methods

### 2.1. Participants

All participants were baccalaureate nursing students regularly admitted full time to the traditional curriculum undergraduate nursing program at the University of Colorado Colorado Springs. Exclusion criteria were age < 20 or > 25 years at time of enrollment, pregnancy, use of anti-anxiety or anti-depressant medications, or any health condition that would prevent participants from engaging in regular physical activity. The study protocol was submitted for human subjects review and approved by the Institutional Review Board of the University of Colorado Colorado Springs, and all participants signed an informed consent prior to enrollment.

### 2.2. Design

The study used a prospective, descriptive design to allow researchers to follow students over the last three semesters of their nursing program, based on an a priori decision that this time period would be representative of their normal activity patterns. Recruitment commenced at the beginning of the spring semester, one year prior to graduation, and participants completed a total of six measurement sessions (two measurements per semester) throughout the three semesters prior to graduation. Baseline measurement was completed immediately after enrollment during weeks 1–2 of the first semester (time 1) and the second measurement was completed during weeks 14–15 of the same semester (time 2). Subsequent measurements were taken during weeks 1–2 and 14–15 of the second (fall) and third (spring) semesters immediately prior to graduation (times 3–6). All data were collected by the study authors over a 2-year period between January 2014 and May 2016.

### 2.3. Measurements

Height was measured at baseline (time 1) using a portable stadiometer. Participants were measured without shoes, with their backs aligned against the stadiometer, and heads erect. The measuring tongue was lowered and aligned with the top of the participant's head. The baseline height was used for all other measurement sessions.

Weight was measured in kilograms using a calibrated digital scale. Participants were asked to remove shoes and coats, and to void prior to the procedure in order to obtain the most accurate measurement of body weight.

Body mass index (BMI) was calculated using the formula: Weight (kg) ÷ Height<sup>2</sup> (m<sup>2</sup>).

Physical activity was assessed using the short form International Physical Activity Questionnaire (IPAQ), a 7-question self-report validated for use by adults over the age of 18 years (Craig et al., 2003). The IPAQ provides subjective physical activity data for the last 7 days. It has previously been used to evaluate physical activity among undergraduate nursing students in the United Kingdom and Australia (Blake et al., 2017; Hawker, 2012; Mc Sharry and Timmins, 2016; Micalos et al., 2017). The IPAQ calculates physical activity as MET-minutes/week of walking (at work, at home, to travel from place to place, or solely for recreation, sport, exercise or leisure), moderate intensity (carrying light loads, bicycling at a regular pace, or doubles tennis), and vigorous intensity (heavy lifting, digging, aerobics, or fast bicycling) activities. Physical activity can then be categorized based on total MET-minutes/week as *low* (< 600 MET-minutes/week), *moderate* (at least 600 MET-minutes/week), or *high* (at least 3000 MET-minutes/week).

### 2.4. Statistical analysis

Data were analyzed using SPSS version 24, with mean and standard deviation (SD) reported for all measurements. Significance was set at  $p < 0.05$ . For between-group comparison, participants were grouped into two physical activity levels (moderate and high) based on total MET-minutes/week. Repeated measures ANOVA was used to evaluate overall changes over time and between-group (group X time interactions) differences based on physical activity levels. When a significant difference was found, either change over time or group X time interaction, *t*-tests were used to identify specifically where those differences occurred. Pearson correlation analysis was used to assess relationships between age, BMI, and physical activity.

## 3. Results

Fifty-two students completed the study over a three-year period with 98% adherence. Males made up only 8% ( $n = 4$ ) of the sample, so no analysis by gender was conducted. Eighty percent ( $n = 42$ ) were White, 4% ( $n = 2$ ) were Black, 8% ( $n = 4$ ) were Hispanic, 2% ( $n = 1$ ) were Asian, and 6% ( $n = 3$ ) described themselves as multiracial. Average age was  $21.3 \pm 1.4$  years, and baseline BMI was  $23.5 \pm 2.9$  kg/m<sup>2</sup>. Over time, body weight and BMI increased gradually (Table 1). The increase in weight did not achieve significance ( $p = 0.07$ ), although by the final semester before graduation (measurements 5–6), average BMI had significantly increased to  $23.9 \pm 3.1$  ( $p = 0.016$ ) and  $23.9 \pm 3.2$  ( $p = 0.039$ ) kg/m<sup>2</sup>, respectively. Correlation analysis revealed no consistent relationship between age or BMI, and any of the physical activity variables during the study period.

Total physical activity did not change over time. At baseline, participants reported an average of  $4236 \pm 2799$  MET-minutes/week, compared to  $4094 \pm 2853$  MET-minutes/week at the last measurement (time 6) prior to graduation (Table 1). Walking was the most frequently reported activity, followed by vigorous activity, and lastly moderate activity (Fig. 1). Furthermore, distinctive physical activity patterns were observed. Although moderate activity remained stable over time, walking and vigorous activities demonstrated somewhat opposing patterns. Initially, over the first 3 measurements (times 1–3), walking increased ( $p = 0.002$ ) while vigorous activities decreased ( $p = 0.029$ ). Thereafter, walking decreased back to approximately baseline values, while vigorous activity increased again, although prior to graduation (time 6) it remained significantly lower ( $p = 0.037$ ) than at baseline.

Participants were then grouped for analysis by physical activity category based on initial (time 1) total MET-minutes per week. Three participants had missing data that did not allow calculation of total MET-minutes per week at baseline, and so were not included in this part of the analysis. In total, 49 students were grouped as either moderate (MA;  $n = 20$ ) or high (HA;  $n = 29$ ) activity. Only one student met the criteria for low activity and so was included in the MA group.

**Table 1**  
Student (N = 52) anthropometrics and physical activity over three semesters prior to graduation.

	Baseline	Time 2	Time 3	Time 4	Time 5	Time 6
Weight (kg)	65.1 (9.5)	65.0 (9.4)	64.7 (9.0)	65.6 (9.7)	66.0 (9.9)	66.0 (10.3)
BMI (kg/m <sup>2</sup> )	23.5 (2.9)	23.4 (2.9)	23.4 (2.7)	23.8 (3.0)	23.9 (3.1)*	23.9 (3.2)*
Physical activity (MET-min/week)						
• Total	4236.3 (2799.6)	4517.2 (2814.0)	4916.5 (2874.7)	4324.7 (2715.3)	4242.4 (2507.2)	4094.4 (2853.5)
• Walking	1643.9 (1517.3)	1872.2 (1540.6)	2398.8 (1488.7)*	1909.9 (1408.2)	1808.7 (1452.1)	1788.4 (1426.8)
• Vigorous	1696.2 (1410.8)	1554.6 (1284.5)	1252.8 (1408.1)*	1410.9 (1285.1)	1518.6 (1444.5)	1254.4 (1175.1)*
• Moderate	844.0 (867.9)	1027.8 (1172.0)	1119.2 (1122.4)	1048.8 (1100.9)	909.6 (952.9)	995.0 (1121.5)

Data presented as Mean (SD).

BMI = Body Mass Index.

\* Significant difference from baseline (*p* < 0.05).

Interestingly, the MA group was younger than the HA group (20.8 ± 1.0 vs. 21.6 ± 1.5 years, *p* = 0.027). There was no difference in BMI between groups at any time during the study. Initial BMI values were 23.5 ± 2.6 kg/m<sup>2</sup> for the MA group and 23.6 ± 3.1 kg/m<sup>2</sup> for the HA group. At end of study, immediately prior to graduation, both groups had increased (*p* = 0.021) to 23.9 ± 3.3 kg/m<sup>2</sup> and 23.9 ± 3.1 kg/m<sup>2</sup>, respectively.

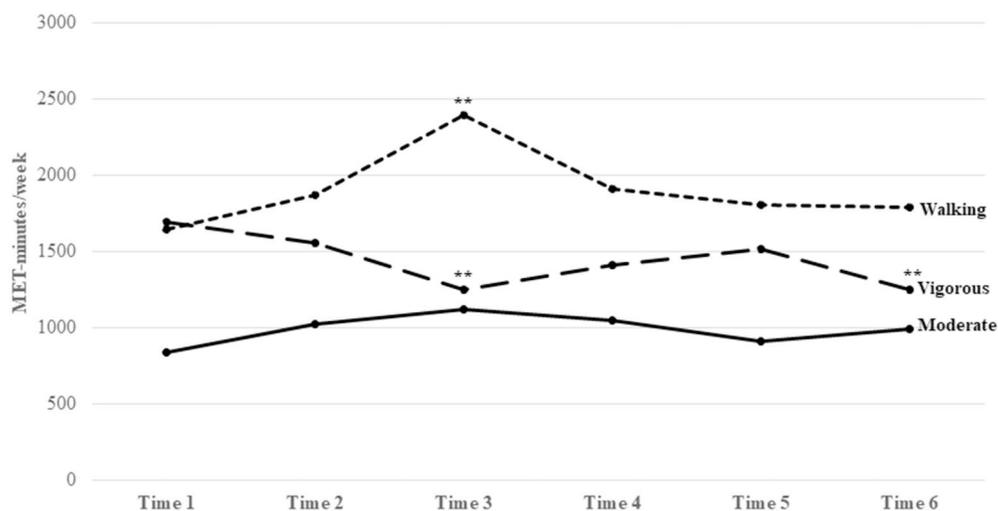
Physical activity patterns did differ between groups. Not surprisingly, the HA group reported overall greater levels of moderate activity, walking, and vigorous activity throughout the study (Table 2; Figs. 2-4). Between-group differences in moderate activity (Fig. 2) were significant during the first (time 1: *p* = 0.001; time 2: *p* = 0.003) and last (time 5: *p* = 0.005; time 6: *p* = 0.013) semesters, but during the second semester (times 3–4), the MA group increased their level of physical activity while the HA group maintained relatively stable levels, so group differences were no longer statistically significant. However, the MA group remained between 27 and 66% lower than the HA group throughout the study. By comparison, between-group differences in walking (Fig. 3) were significant during the first semester (time 1: *p* = 0.000; time 2: *p* = 0.036) and at the end of the last semester (time 6: *p* = 0.019). Similar to what was observed with moderate activity, the MA group increased walking during the second semester (times 3–4) and at the beginning of the last semester (time 5), so differences were no longer significant. However, despite these increases, the MA group remained between 20 and 75% lower than the HA group throughout the study.

The pattern of vigorous activity (Fig. 4) was markedly different than for moderate activity and walking. Initially (time 1), there was a significant (*p* = 0.000) between-group difference, with MA reporting 58%

less vigorous activity. However, by the end of the first semester (time 2), vigorous activity levels had decreased dramatically in the HA group and begun to increase somewhat in the MA group, so they were no longer significantly different. These trends continued until the beginning of the last semester (time 5) when the MA group actually exceeded the HA group by 20%. Thereafter, the MA group decreased back to baseline levels, while the HA group increased slightly, although it remained below baseline levels, resulting in a statistically significant (*p* = 0.016) difference at time 6 just prior to graduation when the MA group was 49% lower than the HA group.

#### 4. Discussion

To our knowledge, this is the first longitudinal study of physical activity among baccalaureate nursing students. Our principle finding was that over time, total physical activity remained stable and on average, students were able to maintain high levels of physical activity, which have been recommended for long-term health benefits (Haskell et al., 2007). Current U.S. recommendations for healthy adults over the age of 18 are to achieve at least 750 MET-min/week (Haskell et al., 2007). As can be seen from Table 1, the students in this study far exceeded those minimal recommendations. In fact, their total physical activity level exceeded levels that have previously been reported for nursing students in the United Kingdom and Australia using the IPAQ for measurement (Blake et al., 2017; Micalos et al., 2017). Throughout the study, walking was the predominant activity, which is consistent with previous research (Hawker, 2012) and may not be surprising, given the amount of walking involved in clinical activity. For example, in the United States registered nurses walk an average of four miles



**Fig. 1.** Changes in physical activity over 3 semesters prior to graduation.

While moderate activity remained stable over time, vigorous activity decreased sharply over the first three measurement periods, increased for the following two measurements, and then decreased again over the last semester immediately prior to graduation. By comparison, walking demonstrated an opposite pattern in which it increased sharply over the first three measurements and then decreased again to approximately baseline values.

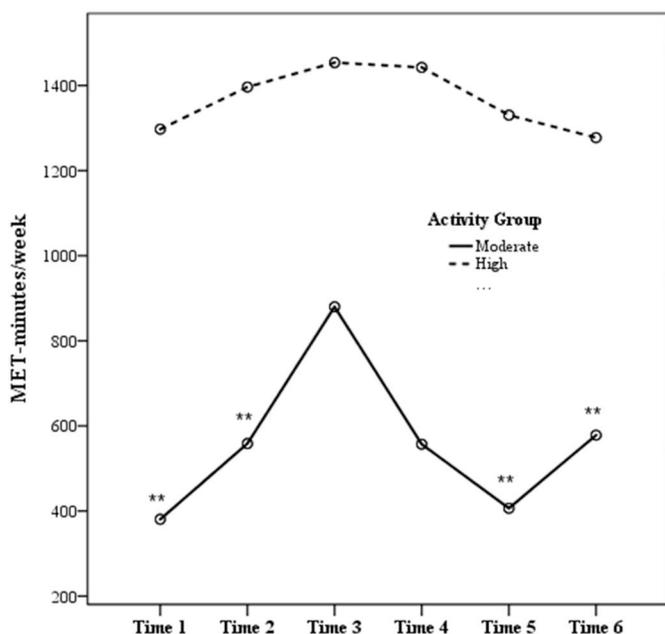
\*\*Significantly different from baseline (Time 1) *p* < 0.05.

**Table 2**  
Differences in physical activity over three semesters prior to graduation between students grouped by baseline MET-min/week as moderate (n = 20) or high (n = 29).

	Baseline	Time 2	Time 3	Time 4	Time 5	Time 6
Physical activity (MET-min/week)						
Total activity						
Moderate	1770.6 (670.6)*	3151.1 (1942.3)*	3917.4 (2184.4)	3332.6 (2366.8)*	3607.9 (2059.4)	2458.4 (1324.3)*
High	5936.8 (2407.0)	5449.3 (3016.3)	5595.9 (3129.0)	5011.1 (2862.5)	4563.4 (2776.1)	5086.3 (3223.1)
Walking						
Moderate	437.7 (375.2)*	1324.1 (1344.9)*	2157.4 (1535.2)	1507.3 (1180.6)	1485.0 (1314.2)	1158.4 (1104.7)*
High	2508.6 (1444.9)	2232.62 (1584.3)	2680.3 (1445.9)	2086.3 (1547.8)	1996.5 (1540.7)	2107.7 (1540.4)
Vigorous activity						
Moderate	936.0 (649.6)*	1316.0 (1313.1)	1026.7 (1203.7)	1225.3 (1241.7)	1634.4 (1721.4)	804.2 (845.2)*
High	2246.9 (1567.5)	1689.7 (1306.9)	1406.9 (1557.7)	1576.6 (1347.1)	1358.6 (1178.5)	1582.9 (1287.6)
Moderate activity						
Moderate	369.9 (256.7)*	511.0 (488.4)*	924.4 (987.9)	700.0 (839.8)	490.0 (524.9)*	529.8 (656.8)*
High	1181.4 (993.7)	1434.3 (1409.3)	1273.1 (1238.7)	1273.3 (1231.3)	1191.1 (1055.6)	1289.3 (1311.5)

Data presented as Mean (SD).

\* Significant difference between groups ( $p < 0.05$ ).



**Fig. 2.** Differences in moderate physical activity.

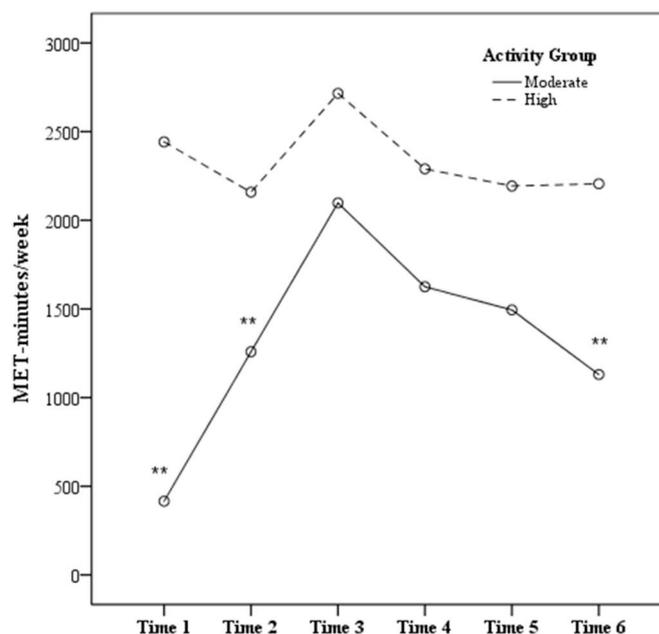
The high activity (HA) group was significantly greater than the moderate activity (MA) group during the first and last semesters. During the second semester, the MA group increased its level of moderate activity and both groups were statistically similar.

\*\*Significantly different between groups ( $p < 0.05$ ).

during a shift on a medical/surgical unit (Welton et al., 2006).

By comparison, the opposing patterns of walking and vigorous activity were somewhat surprising. Generally, when walking increased, vigorous activity decreased, and vice versa. Vigorous activity includes what we often characterize as “exercise,” so this pattern may reflect regular engagement in exercise-related activities that students defer when other activities that require greater amounts of walking increase. Although it is possible our data do not reflect a true assessment of activity, the IPAQ has been validated specifically for measurement of walking and vigorous activity in adolescents and college students (Dinger et al., 2006; Rangul et al., 2008). However, in recognition of the limitations of subjective activity measurement, future research using objective measures is recommended.

The increases in body weight and BMI were also notable. Although changes in weight did not achieve significance, BMI did significantly increase over time. At baseline, our students were within the normal weight BMI category, which is consistent with a previous cohort of



**Fig. 3.** Differences in walking.

The high activity (HA) group was significantly greater than the moderate activity (MA) group during the first semester and at the end of the last semester, immediately prior to graduation. Similar to the pattern observed for moderate activity, walking increased in the MA group during the second semester, and the increase was retained through the beginning of the last semester, such that both groups were statistically similar during that period of time.

\*\*Significantly different between groups ( $p < 0.05$ ).

nursing students described by Mc Sharry and Timmins (2016), but not with the students described by Hawker (2012) who were overweight. Interestingly, the students described by Mc Sharry and Timmins (2016) had an average age of 22 years, which is similar to our students, while the students described by Hawker (2012) had an average age of 27 years. In light of the increase in BMI we observed during our study period, the difference in BMI between the nursing cohorts may simply reflect the weight gain that occurs over time among college students (de Vos et al., 2015; Nikolaou et al., 2015; Pope et al., 2017; Racette et al., 2008) and young adults (Han et al., 2014; Kaikkonen et al., 2015). Nonetheless, although our students' BMI remained within the normal weight category, the upward trend was concerning, given the health risks associated with overweight and obesity (Flegal et al., 2013; Hirko et al., 2015; Yatsuya et al., 2014).

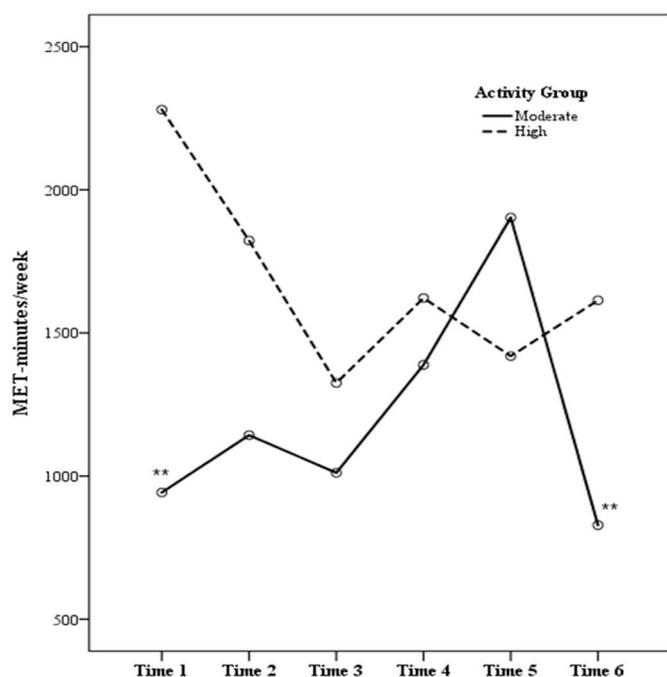


Fig. 4. Differences in vigorous physical activity.

The high activity (HA) group was significantly greater than the moderate activity (MA) group only at the first and last measurement sessions (beginning of the first semester and the end of the last semester just prior to graduation). During the study mid-point (end of the first semester through the beginning of the last semester) vigorous activity decreased dramatically in the HA group and remained well below baseline levels throughout the rest of the study period. By comparison, in the MA group, vigorous activity increased dramatically at the beginning of the second semester and continued to increase through the beginning of the last semester when it exceeded the HA group, after which it decreased dramatically back to baseline levels.

\*\*Significantly different between groups ( $p < 0.05$ ).

When students were compared based on total physical activity levels, distinct patterns of activity were also observed. Moderate activity and walking remained stable over time in the high activity group, but varied dramatically in students with lower overall physical activity. Specifically, walking and moderate activity were highest at time 3 that corresponded to the first measurement after our university's summer break. It is possible that this reflects a difference in activity between academic and non-academic times of the year, and should be considered in any future research evaluating physical activity in this population.

In contrast, vigorous activity patterns did not follow a similar pattern. Although students with higher levels of overall physical activity reported greater amounts of vigorous activity at baseline, this did not remain consistent. Vigorous activity decreased dramatically after the first measurement and was lowest at time 3 immediately after the summer break. By comparison, students with lower overall physical activity reported stable levels of vigorous activity through time 3, but then sharply increased their vigorous activity, and by time 5 at the beginning of the last semester had exceeded the high activity group. Subsequently, vigorous activity dropped and by the end of the study, students with lower physical activity again reported significantly less vigorous activity. We are at a loss to explain this phenomenon and recognize that it may represent an unidentified confounding influence. Furthermore, a search of the existing literature did not identify any previous studies evaluating changes in physical activity patterns by levels of intensity, which would at least provide a comparison with our findings.

The major strength of our study was the use of a longitudinal design that allows comparison over multiple time points. As we have previously remarked, we cannot find any previous descriptive studies that are not cross-sectional. A major limitation was the small sample of 52

students. Although a small sample increases the risk for a type II error, we did observe significant changes over time and differences between groups. A second limitation was our use of a subjective measure for physical activity. However, the IPAQ is a well-validated tool that has previously been used to measure physical activity among nursing students.

## 5. Conclusions

Based on our findings, baccalaureate nursing students maintain high physical activity levels that exceed U.S. recommendations to promote personal health. Furthermore, based on our current understanding of the relationship between healthcare providers' personal lifestyle choices and their engagement in patient counselling, the physical activity levels reported by nursing students in this study make them more likely to provide effective health education after graduation. We recommend that nurse educators actively encourage physical activity throughout the academic year. In particular, engagement in vigorous activities that seem to be the least stable over time should be emphasized.

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