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The Relationship Between Accelerometer-determined Physical Activity and Clinical Low Back Pain Measures in Adolescents with Chronic or Sub-Acute Recurrent Low Back Pain

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Abstract

Study Design—Cross-sectional

Objectives—Assess the relationship between objective physical activity measures assessed by accelerometers and standard clinical measures (pain intensity, disability, quality of life) in a sample of adolescents with recurrent or chronic low back pain (LBP).

Background—Although LBP occurs commonly in adolescence, little is known about the relationship between objectively measured physical activity and chronic LBP.

Methods—The study used a sub-sample of 143 adolescents, 12 – 18 years of age, from a randomized clinical trial. Pearson's correlation (r) and bivariate linear regression were used to assess the relationship between baseline measures of sedentary, light, and moderate-to-vigorous physical activity using accelerometers and clinical measures of LBP (pain intensity, disability, and quality of life).

Results—Adolescents spent an average of 610.5 minutes in sedentary activity, 97.6 minutes in light physical activity, and 35.6 minutes in moderate-to-vigorous physical activity per day. Physical activity was very weakly associated with clinical measures of LBP ($|r| < 0.13$). None of the assessed correlations were statistically significant and bivariate regression models showed physical activity measures explained very little of the variability for clinical measures of LBP ($R^2 < 0.02$).

Conclusion—We found no important relationship between objectively measured physical activity and self-reported LBP intensity, disability, or quality of life in adolescents with recurrent or chronic LBP.

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Keywords

Disability; lumbar spine; quality of life

Low back pain (LBP) is a well-recognized public health problem associated with a high prevalence, large amount of disability, and reduced quality of life.²⁵ Although commonly perceived as a problem limited to adults, episodes of LBP frequently occur during childhood, with a prevalence similar to adults by late adolescence.⁹ Given the early onset and cumulative lifetime burden of LBP, a better understanding of the relationship between modifiable behavioral factors, such as physical activity, and the LBP experience is important.

Physical activity recommendations are a common part of LBP management. A hallmark of patient education materials for LBP is advice to “stay active” and avoid prolonged periods of sedentary behavior.⁵ In addition, general aerobic exercise is commonly recommended for both management and prevention of LBP.¹² Physical functioning, which includes physical activity, is also a recommended core outcome domain in clinical trials of chronic and recurrent pain in children,¹³ emphasizing the importance of better understanding the role physical activity plays in modifying the LBP experience.

Physical activity measurement commonly relies on subjective self-report questionnaires due to their ease of administration and low cost.¹⁸ Objective activity measurement utilizing accelerometers has become increasingly common and accessible.¹⁸ Objective measurement tools applied over several entire days are considered to be more accurate in capturing physical activity patterns, because many observer, recall, and response biases are avoided.¹⁴

Although well regarded as an important element in the clinical profile and management of LBP, the relationship between physical activity and the LBP experience is not well understood. No studies, that we are aware of, have examined the association between physical activity levels and clinical measures of LBP in adolescents currently with the condition. The aim of this study was to assess the relationship between objectively measured physical activity levels using accelerometers and standard clinical measures of pain intensity, disability, and quality of life in a population of adolescents with recurrent or chronic LBP. We hypothesized higher levels of physical activity would be negatively associated with pain intensity and disability, and positively associated with quality of life. Our hypothesis was informed by our clinical experience that increased pain intensity often restricts physical activity levels.

METHODS

Design and Participants

This study was a planned secondary analysis of data collected in a parent, prospective parallel-group, randomized clinical trial (RCT) investigating non-surgical treatment approaches for adolescents with LBP. The study protocol for the parent RCT has been published.¹⁶ A sample of 143 participants recruited and enrolled at a single site (University-associated research clinic in Bloomington, Minnesota) within a 2-site RCT was used for this

secondary analysis. Eligible participants were 12 to 18 years of age with sub-acute recurrent or chronic LBP and a self-rated pain intensity (typical level during the past week) 3 on a 0 to 10 numerical rating scale. The participant's LBP was considered sub-acute recurrent if the current episode lasted 2–11 weeks in duration and they experienced a prior episode lasting 2 weeks or longer in the past year. Current episodes of LBP lasting 12 weeks or longer were classified as chronic. Participants were recruited from the general population using a variety of methods including post-card mailings (primary method), Facebook and Craigslist advertisements, newspaper advertisements, flyers, and letters to local physicians and youth coaches. Individuals with contraindications to study interventions or competing comorbidities were excluded. A detailed description of the parent RCT protocol has been previously published.¹⁶ The Institutional Review Boards at Northwestern Health Sciences University (Minnesota, USA) and the University of Western States (Oregon, USA) approved the parent RCT. This secondary analysis was approved by the Institutional Review Boards at University of Minnesota – Twin Cities (Minnesota, USA). The parent RCT was registered at ClinicalTrials.gov (study #: NCT01096628).

Physical Activity Measures

Physical Activity was measured using a GT3X accelerometer (Actigraph, Inc., Pensacola, FL), which has been demonstrated to be a reliable and valid measure of physical activity among children.³ Participants wore the device for 7 consecutive days prior to randomization. Over the course of the 7-day assessment period, participants were instructed to wear the accelerometers on their waist during all waking hours with the exclusion of activities involving water (e.g., swimming, bathing). Data from the GT3X accelerometers were analyzed with ActiLife (Version 6.13.3, Pensacola, FL) using age appropriate parameters to characterize physical activity.¹⁹ Activity counts were set at 15-second epochs. The use of 15 second epochs for analysis is based upon the recommendations made by Trost et al.¹⁹ It represents the time frame short enough to accurately capture the movement of the adolescents and mirrors the chosen epoch length of past adolescent physical activity literature.⁴ Data were truncated to ensure that there was valid wear time, defined as at least 10 hours per day with at least 2 days of weekday wear and 1 day of weekend wear.^{4, 19} Non-wear time was defined as 60 minutes of continuous inactivity interrupted by no more than 2 minutes of activity. Empirically-based cut points were used to discern different intensities of physical activity (sedentary: 0 – 100 counts/minute; light physical activity: 101 – 2295 counts/minute; and moderate-to-vigorous physical activity [MVPA]: greater than 2296 counts/minute).⁶ The outcome variables of interest were the total and percentage of time spent in sedentary behavior, light physical activity, and MVPA.

Clinical Measures

Clinical measures related to LBP were assessed twice during the baseline period (at 14 and 7 days prior to randomization). Clinical measures from the assessment 7 days prior to randomization were used for this secondary analysis.

Participant-rated Low Back Pain Intensity were measured using the 11-box numerical rating scale (NRS) where 0 represents *no pain* and 10 represents *worst pain possible*. Participants were asked to rate their typical pain intensity from the previous week. The 11-box NRS for

pain has been shown to perform similarly to the visual analogue scale in both pediatric and adult populations.^{8, 24}

Disability was assessed using the 18-item Roland-Morris Disability Questionnaire which assesses difficulty performing daily activities and is scored on a 0 – 18 scale where 0 reflects *no disability* and 18 reflects *maximum disability*. Participants were asked to assess their current level of difficulty in performing various activities of daily living. This shorter version of the original 24-item Roland-Morris Disability Questionnaire has been shown to be reliable, valid, and as responsive as the original instrument.^{11, 17}

Quality of Life was measured using the 23-item Pediatric Quality of Life Inventory (PedsQL) instrument, a multidimensional scale appropriate for measuring physical, emotional, social, and school functioning in children 8 to 18 years old. Summary scores for psychosocial, physical, and total health were then computed on a 0 – 100 scale where 0 represents *lowest possible quality of life* and 100 represents *highest possible quality of life*. Participants were asked to rate their quality of life over the past month. The PedsQL is a reliable, valid, and responsive measure of quality of life in youth.^{10, 21–23}

Data Analysis

The clinical and demographic characteristics of participants excluded from the analysis due to non-compliant accelerometer wear time were compared to included participants using independent t-tests for continuous measures and chi-square tests for categorical outcomes.

Descriptive statistics (means, standard deviations, frequencies, percentiles) were calculated to summarize objective physical activity measures. In addition, the proportion of participants meeting the United States recommendations for physical activity for adolescents (60 minutes of MVPA per day) was determined.

Pearson's correlation and bivariate linear regression models were used to assess the relationships between clinical measures of LBP (LBP intensity, disability, and quality of life as dependent variables) and objective physical activity measures (percentage of time in sedentary behavior, light physical activity, MVPA as independent variables). The strength of correlation was categorized according to absolute magnitude as follows: (1) very weak: 0.0 to < 0.3; (2) weak: 0.3 to < 0.5; (3) moderate: 0.5 to < 0.7; (4) strong: 0.7 to < 0.9; and (5) very strong: 0.9 to 1.0.⁷ Multivariate regression analyses were not used due to the inter-relationship between the objective physical activity measures and the strong potential for collinearity. A significance level of 0.05 was used for all statistical tests. All statistical analyses were conducted using Stata version 13.1 (StataCorp, College Station, TX, USA).

RESULTS

Descriptive Analyses

Fifty participants were excluded from the analyses due to insufficient amount of valid accelerometer wear time, leaving 93 participants in the final sample. The clinical and demographic characteristics of included and excluded participants are provided in TABLE 1.

Included and excluded participants were similar in terms of demographics and clinical characteristics. Participants were predominantly female (71%) with moderately intense LBP.

Descriptive statistics for objectively measured physical activity are provided in TABLE 2. On average, adolescents spent 82.0% of the time (610.5 minutes) in sedentary activities, 13.1% of the time (97.6 minutes) in light physical activity, and 4.8% of the time (35.6 minutes) in MVPA on a daily basis. Although approximately 56% of participants spent an average of 30 minutes or more in MVPA per day, only a small proportion (10.8%, $n = 10$ of 93) met the threshold of 60 minutes or more per day as recommended by the *2008 Physical Activity Guidelines for Americans*²⁰ for children and adolescents.

Relationship between Clinical and Physical Activity Measures

The results from the correlation and bivariate linear regression analyses between objective physical activity measures and clinical measures of LBP are provided in TABLE 3. Overall, no notable relationship between the objective physical activity measures and clinical measures of LBP was found. Objectively measured physical activity was very weakly associated with LBP intensity ($r = -0.1$ to 0.08), disability ($r = -0.03$ to 0.03), and quality of life ($r = -0.13$ to 0.04). None of the correlations were statistically significant ($p > .05$). In addition, regression analysis showed that objective physical activity measures explained only a trivial amount of the variance of clinical measures in adolescents with LBP ($R^2 < 0.02$). Scatterplots of the objective physical activity measures with LBP intensity are included in the FIGURE 1 and provide a visual depiction of the absence of important relationships between these measures.

DISCUSSION

This study assessed cross-sectional relationships between objectively measured physical activity levels and clinical measures of LBP in adolescents. Overall, we found objective physical activity measures were not importantly associated with clinical measures of LBP and explained only a small amount of their variability. While this is the first study to specifically assess this relationship in adolescents with LBP, an absence of association between pain intensity and objectively measured physical activity has been reported by Wilson and Palermo for adolescents with various chronic pain conditions.²⁶ Similar to our study, the authors used average measures of pain intensity (over a month) and physical activity (over a week) to assess the relationship.²⁶ In other research, however, Rabbitts et al. found an association between daily measures of pain intensity and physical activity for various chronic pain conditions.¹⁵ Higher pain intensity levels were shown to be predictive of lower physical activity on the following day and higher physical activity levels were shown to be predictive of lower pain intensity on the same day.¹⁵ The association between daily pain intensity and physical activity in adolescents with various chronic pain conditions (e.g. headache, abdominal pain) may not apply to adolescents with LBP. Investigation into the relationship between daily measures of physical activity and low back pain and disability in adolescents is warranted.

Current United States recommendations for MVPA in children and adolescents are 60 minutes/day.²⁰ Only 10.8% of the current sample of adolescents with LBP met this

recommendation. Participants in the current study spent the majority of their day performing sedentary activity, with an average of 97.6 minutes in light physical activity and 35.6 minutes in MVPA. The proportion of adolescents overweight (35.5%) or obese (15.1%), using 85th and 95th sex-specific BMI-for-age percentiles from the CDC, was similar to US population estimates using the National Health and Nutrition Examination Survey.²⁷ The distribution of time spent in MVPA per day (minimum = 11.5 min; median = 32.1 min; maximum = 78.9 min) for this sample of adolescents with LBP is also similar to the United States population-based norms.²⁸ However, study participants spent much less time in light physical activity per day (minimum = 32.1 min; median = 96.1 min; maximum = 211.5 min) relative to the United States population of 12 – 18 year olds (median time of 300 minutes or more depending on age and gender).²⁸ These findings, although drawn from an indirect comparison, suggest the amount of time adolescents spend in sedentary behavior relative to light physical activity may be more important for the relationship with LBP than the amount of time devoted to MVPA. Among individuals with LBP, it is difficult to determine if lower levels of physical activity are a cause or effect of LBP. Interestingly, we found no important association between the amount of sedentary or light physical activity with the amount of pain intensity, disability, or quality of life in adolescents with LBP; this suggests these factors are less important for the ongoing clinical experience of LBP and may be more of a protective factor. Direct comparisons of how adolescents with chronic LBP compare to healthy controls in terms of physical activity has received little research attention. One small cross-sectional study reported a non-significant difference in MVPA between Australian adolescents with chronic LBP (1158 minutes/week) and healthy controls (919 minutes/week).¹ There is a need for studies which directly compare the amount of objectively measured sedentary, light physical activity, and MVPA between United States adolescents with chronic LBP and matched controls.

Strengths of the current study include the use of an objective measure of physical activity (i.e., accelerometers), the use of standard thresholds to characterize physical activity, and the use of robust self-reported LBP-related measures recommended by the Pediatric Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (PedsIMMPACT) group.¹³ Several limitations must also be acknowledged when interpreting the findings of the current study. First, a number of participants (n = 50) did not meet the threshold for acceptable accelerometer wearing time and were excluded from the analysis. Given that participants excluded from the analysis had very similar demographic and clinical characteristics to included participants, we think it is likely that their exclusion had little impact on our conclusions, but the true impact is unknown. The perceived unfavorable appearance of the device and discomfort associated with wearing an accelerometer have been highlighted as two factors contributing to low wear-time compliance in previous research.² A large proportion of participants noted they participated in sporting or club activities but, interestingly, MVPA did not differ between adolescents who participated in these activities and those who did not (data not shown). This suggests there is a possibility that participants removed the accelerometers when practicing or competing in athletic events (e.g., football, volleyball, swimming). It may have been useful to collect an activity diary from participants to help clarify the occurrence of accelerometer removal during intense activities, but this was not practical as it would have increased patient burden in the parent RCT. Another limitation

was the cross-sectional analysis that only assesses the relationship between physical activity and LBP at a single point in time that may not have accounted for daily fluctuation in pain and activity. Finally, the vast majority of study participants presented with chronic LBP (96%). The relationship between physical activity and clinical measures of LBP may differ in acute or sub-acute populations.

CONCLUSION

Objectively measured physical activity was very weakly and not importantly associated with self-rated LBP intensity, disability, or quality of life in adolescents with recurrent or chronic LBP. Future studies directly comparing individuals with and without LBP, as well as collecting frequent measures of physical activity and clinical LBP measures in a longitudinal fashion, are needed to better understand the relationship between physical activity and LBP.

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KEY POINTS**Findings**

Objectively measured physical activity was very weakly and not importantly associated with self-rated LBP intensity, disability, or quality of life in adolescents with recurrent or chronic LBP.

Implications

The level of physical activity is not related to LBP burden at a single point in time; however, the potential impact on the course of LBP remains unknown.

Caution

The study examined cross-sectional associations in adolescents with LBP. Differences in physical activity between adolescents with and without LBP may exist.

FIGURE 1.
Scatterplot for objective physical activity measures and low back pain intensity.

TABLE 1

Demographic and clinical characteristics of included and excluded participants *

	Included sample (n = 93)	Excluded sample (n = 50)	P-value
Age (years)	15.6 (1.7)	15.1 (1.7)	.15
Female [% (n)]	71.0 (n=66)	70.0 (n=35)	.90
BMI (kg/m ²)	23.7 (5.3)	23.1 (4.6)	.45
Family Income [% (n)]			.65
Less than \$10,000	0% (n=0)	2.2% (n=1)	
\$10,000 to \$14,999	1.2% (n=1)	2.2% (n=1)	
\$15,000 to \$24,999	2.4% (n=2)	2.2% (n=1)	
\$25,000 to \$34,999	6.0% (n=5)	4.4% (n=2)	
\$35,000 to \$49,999	12.1% (n=10)	8.7% (n=4)	
\$50,000 to \$74,999	31.3% (n=26)	21.7% (n=10)	
\$75,000 or more	47.0% (n=39)	58.7% (n=27)	
Chronic LBP [% (n)]	95.7 (n=89)	94.0 (n=47)	.65
LBP intensity (0–10)	5.6 (1.6)	6.0 (1.5)	.17
Quality of life (0–100)	75.7 (12.3)	74.2 (13.4)	.50
Disability (0–18)	5.3 (3.6)	5.7 (3.6)	.47
Sports or club participation [% (n)]	75.3 (n=41)	82.0 (n=70)	.41

* Data are means and standard deviations unless otherwise indicated

Abbreviations: BMI = body mass index; LBP = low back pain

TABLE 2

Descriptive statistics for objective physical activity measures

	Mean (sd)	Minimum	25 th Percentile	Median	75 th Percentile	Maximum
Physical activity per day (minutes)						
Sedentary	610.5 (77.6)	443.2	564.4	611.9	665.1	893.0
Light Physical Activity	97.6 (29.0)	32.1	78.5	96.1	110.6	211.5
Moderate-to-Vigorous Physical Activity	35.6 (15.9)	11.5	24.0	32.1	44.8	78.9
Physical activity per day (% of time)						
Sedentary	82.0 (4.7)	66.0	78.6	83.2	85.6	91.1
Light Physical Activity	13.1 (3.7)	5.9	10.6	12.5	15.2	30.7
Moderate-to-Vigorous Physical Activity	4.8 (2.2)	1.4	3.2	4.2	6.1	10.4

TABLE 3

Correlation and regression results among clinical and objective physical activity measures (N = 93)

	Clinical measures		
	Low back pain intensity	Quality of life	Disability
Physical activity measures (% of day)			
Sedentary activity			
Pearson's r	-0.099	0.005	0.030
Regression coefficient (SE)	-0.034 (0.036)	0.012 (0.275)	0.023 (0.080)
RMSE	1.62	12.40	3.62
R ²	0.010	0.000	0.001
Light physical activity			
Pearson's r	0.083	-0.027	0.042
Regression coefficient (SE)	0.036 (0.046)	-0.089 (0.351)	0.041 (0.102)
RMSE	1.63	12.40	3.62
R ²	0.007	0.001	0.002
Moderate-to-Vigorous physical activity			
Pearson's r	0.0776	0.033	-0.129
Regression coefficient (SE)	0.058 (0.079)	0.190 (0.599)	-0.215 (0.174)
RMSE	1.63	12.39	3.59
R ²	0.006	0.001	0.017

Univariate regression models with a clinical measure as the dependent variable and an objective physical activity measure as the independent variable;

p > 0.05 for all; RMSE = root mean squared error;