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PHYSICAL ACTIVITY AND QUALITY OF LIFE IN LOW BACK PAIN: A TWO-GROUP STRUCTURAL EQUATION MODELING ANALYSIS

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ABSTRACT Studies have indicated that physical activity (PA) reduces pain and enhances quality of life (QoL) in low back pain (LBP). No study has investigated the aforementioned factors within the context of the same theoretical model so far. The aim of this study was to examine the PA and QoL relationship through the intermediary effects of bodily pain (BP) and physical (PCS) and psychological (MCS) health. Participants were 684 individuals aged 39.16 ± 13.52 years old (M ± SD). In total, 222 participants of the sample reported LBP, whereas 462 participants did not. LBP, PA, BP, PCS, MCS and QoL were assessed. A two-group structural equation modeling analysis was used. The results didn't support the model invariance across groups. Within the group with LBP, PA improved QoL through PCS and MCS, whereas in the group without LBP, PA enhanced QoL through MCS. Longitudinal studies should be carried out for highlighting these associations over time.

KEYWORDS : exercise, quality of life, low back pain.

INTRODUCTION

Low back pain (LBP) has been proven to be among the top ten burden diseases with an average number of disability-adjusted life years higher than other diseases (Wu et al., 2020). In addition, LBP has been documented as a leading cause of disability, poor well-being and impaired quality of life (QoL) (Wu et al., 2020). These findings have led to a scientific interest in developing interventions that could effectively manage or minimize the physical and psychosocial effects of LBP and enhance QoL (Crawford et al., 2018).

In particular, recent studies have demonstrated that participation in physical activity (PA) is an effective intervention for reducing LBP and improving QoL (Kofotolis et al., 2016; Natour et al., 2015). Specifically, research findings have indicated that participation in pilates exercise interventions has reduced pain and enhanced QoL in adults with non-specific LBP (Kofotolis et al., 2016; Natour et al., 2015). Further, a bibliometric analysis has observed a beneficial effect of strength/resistance, stretching and coordination/stabilization exercise programs compared to other exercise interventions in the treatment of LBP (Wang et al., 2020). Moreover, patients achieving WHO recommendations in leisure time PA (≥ 600 MET-min / week) have shown a significantly higher health-related QoL compared to patients reporting "no leisure time PA" (Schaller et al., 2015).

The aforementioned findings are in accordance with previous research reports indicating a well-established positive relationship between PA and QoL in healthy adults (McAuley et al., 2008; McAuley & Morris, 2007; Theodoropoulou et al., 2017). Specifically, PA has been positively associated with QoL, which was defined as satisfaction with one's life, through the intermediary effects of exercise self-efficacy, physical (PCS) and psychological (MCS) health status. However, the mechanisms highlighting this association in LBP are not clearly understood, because PA, pain and QoL have not been examined within the context of the same theoretical model. In addition, important concepts, such as PCS and MCS, have not been included in a theoretical model in order to examine the PA and QoL relationship in LBP. According to previous findings PCS and MCS have a mediating role in the relationship between PA and QoL in healthy adults (McAuley et al., 2008; McAuley & Morris, 2007) and therefore, they may serve as mediators in the PA and QoL association in adults with LBP. The examination of the above factors within the context of the same theoretical model, using structural equation modeling (SEM), may highlight the mechanisms and lead to a better understanding of the relationship among PA, pain, health and QoL in LBP.

Therefore, the initial purpose of the current study is to examine a theoretical model of the PA and QoL relationship through the intermediary effects of pain, PCS and MCS in adults with LBP. The second purpose is to evaluate the same theoretical model in individuals without LBP, in order to indicate whether or not the mediating effects differ across the two groups.

METHODS

Participants And Sample Size Calculation

The sample was not randomly selected and consisted of 752 individuals, ranging in age from 18 to 65 years old, who participated in various exercise activities. Due to listwise deletion of missing values and outliers, 684 participants consisting of 206 men (30.12%) and 478 women (69.88%) aged 39.16 ± 13.52 years old (*M* ± *SD*) were used. The participants were categorized into two groups based on the existence or not of LBP.

The criterion of 10 participants per item (10:1 ratio) was utilized for the sample size calculation (Kline, 2005). In addition, a statistical algorithm for SEM was used (www.danielsoper.com), with a power of 0.8, an effect size of 0.1 and a significant level of 0.5, for the sample size calculation.

Assessments

LBP

LBP was evaluated using the following item: "Do you have LBP?". The item was rated on a 2-point scale, yes and no.

PA

The International Physical Activity Questionnaire (IPAQ) short form was used for the PA assessment (Craig et al., 2003). The IPAQ-short form consists of six items measuring exercise frequency and duration and one item estimating sedentary behaviour. The items evaluated walking PA, moderate PA, vigorous PA and total PA indexes. The PA indexes were expressed in MET - minutes per week and were calculated as duration X frequency X MET intensity. Satisfactory validity and reliability of the IPAQ was found (Craig et al., 2003).

QoL

QoL was assessed with the Satisfaction with Life Scale (SWLS, Pavot & Diener, 1993). The SWLS consists of the following items: "in most ways my life is close to my ideal", "the conditions of my life are excellent", "I am satisfied with my life", "so far I have gotten the important things I want in my life", "if I could live my life over, I would change almost nothing". The items were rated on a 7-point scale. Research data indicated satisfactory validity and reliability of the SWLS (Pavot & Diener, 1993)

Pain, PCS, MCS

The Short Form 36 (SF-36) Health Survey (Keller et al., 1998) is a self-report questionnaire consisting of 36 items that evaluate eight first-order factors: physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health. These factors can be grouped under two second-order factors: PCS (physical component summary) and MCS (mental component summary). The first-order factors' scores were transformed into factors' scores using the equations proposed by Ware et al., (2000) except for the bodily pain (BP) factor due to its mediating role in the examined model. Therefore, a 3-factor measurement model was examined through confirmatory factor analysis (CFA) including PCS and MCS second-order factors (Hann & Reeves, 2008) as well as BP. Studies supported the validity and reliability of the questionnaire (Keller et al., 1998).

Design And Procedure

Institutional ethical approval for this cross-sectional study was obtained through the University. Participants filled in a consent form and the questionnaires.

Statistical Analyses

To explore differences between participants with and without LBP in the examined variables, independent-samples *t*-test was conducted using the SPSS 25.0 statistical software (SPSS Inc., Chicago, IL, USA).

Model Testing

The structural model was analyzed following two steps: (a) CFA for assessing the fit of the measurement models and (b) SEM for testing the fit of the structural model (Kline, 2005). In addition, a multiple-group SEM analysis was performed to determine whether or not the proposed model was equivalent across groups (participants with LBP and participants without LBP). The AMOS 26.0 statistical software (IBM Corporation, Armonk, NY, USA) was used.

CFA

CFA utilizing maximum likelihood estimation was conducted to evaluate the measurement models. Appropriateness of the items was based on the following criteria: (a) skewness (±2), (b) kurtosis (±2.5), (c) Mardia's coefficient [< p (p + 2), p = number of instrument items], (d) factor loadings (>0.40) and (e) correlation matrix (<0.90) (Russell, 2002).

SEM

A SEM analysis employing maximum likelihood estimation was performed to separately evaluate the structural model's fit for each of the examined groups (Kline, 2005). In particular, the proposed model specifies direct effects of PA on PCS, BP and MCS, which in turn directly affect QoL.

Model fit

Assessment of the model fit was based on the *chi-square* test (X^2), the Satorra-Bentler X^2/df ratio and the Root Mean Square Error of Approximation (*RMSEA*) (Steiger, 1990). Insignificant values of X^2 and values of X^2/df ratio smaller than 3.0 indicate acceptable fit. *RMSEA* values lower than 0.05 represent close fit, between 0.05 and 0.08 acceptable fit, whereas *RMSEA* values greater than 0.08 indicate poor fit of the examined model. Further, estimation of models fit was based on the Comparative Fit Index (*CFI*), Goodness of Fit Index (*GFI*), Incremental Fit Index (*IFI*) and Tucker and Lewis Index (*TLI*) (Bentler, 1990). *CFI, GFI, IFI* and *TLI* values above 0.95 represent very good fit, whereas values above 0.90 indicate acceptable fit.

Cross-group model fit

A multiple-group SEM analysis was conducted to determine whether or not the proposed model was equivalent across the groups (with and without LBP). Cross-group equality constraints were imposed to derive equal assessments of the parameters within two groups (Kline, 2005). In particular, constraints on the regression weights, covariance and residuals were imposed. The fit of the constraint models can be compared with that of the unconstraint model by using the difference in X^2 (X^2_D) value. If theX^2_D value between the models is insignificant, the invariance across groups is supported.

RESULTS

The ratio of participants' number to observed variables was higher than the 10:1 ratio (24.66:1 - group with LBP, 51.33:1 - group without LBP). The number of both groups' participants was higher than the recommended minimum sample size for model's structure (N= 200).

The first group consisted of 222 (32.46%) participants having LBP, whereas the second group consisted of 462 (67.54%) participants without LBP. Participants with LBP had lower values of PA (M = 44.77, SD = 13.88, p < 0.05), QoL (M = 4.56, SD = 1.31, p < 0.05) and PCS (M = 7.17, SD = 0.46, p < 0.01) than participants without LBP (PA: M = 47.75, SD = 14.810, QoL: M = 4.85, SD = 1.17, PCS: M = 7.46, SD = 0.40). The group with LBP had higher values of BP (M = 1.90, SD = 0.14, p < 0.01) than the group without LBP (M = 1.82, SD = 0.17).

CFA results

CFA was conducted using bootstrapping with the Bolen-Stine approach due to the multivariate non-normality (Kline, 2005). As Table 1 presents, the measurement models provided an acceptable fit in both groups.

Table 1 Fit Indices Of The CFA Measurement Models In Participants With And Without LBP.

Participants with LBP (n_1 = 222)							
Questionnaires	X^2	X^2 / df	*CFI*	*GFI*	*IFI*	*TLI*	*RMSEA*
IPAQ	2.299, p = 0.542	1.150	0.923	0.902	0.923	0.918	0.063
SWLS	5.403, p = 0.219	1.351	0.993	0.985	0.993	0.983	0.071
SF-36	6.795, p = 0.055	1.133	0.976	0.980	0.976	0.939	0.079
Participants without LBP (n_2 = 462)							
Questionnaires	X^2	X^2 / df	*CFI*	*GFI*	*IFI*	*TLI*	*RMSEA*
IPAQ	2.321, p = 0.023	1.161	0.910	0.890	0.910	0.905	0.095
SWLS	6.251,	1.563	0.988	0.985	0.988	0.969	0.084

	p = 0.030						
SF-36	8.375, p = 0.015	1.396	0.971	0.980	0.971	0.927	0.091

IPAQ = International Physical Activity Questionnaire; SWLS = Satisfaction with Life Scale; SF-36 = Short Form 36 Health Survey; X^2 = *chi-square* test; *df* = degrees of freedom; p = significance value; *CFI* = Comparative Fit Index; *GFI* = Goodness of Fit Index; *IFI* = Incremental Fit Index; *TLI* = Tucker and Lewis Index; *RMSEA* = Root Mean Square Error of Approximation.

Structural Model's Fit

SEM was conducted by using bootstrapping with the Bolen-Stine approach to assess model fit under non-normal conditions. The structural model provided an appropriate fit for the group having LBP (X^2 = 75.222, *df* = 70, p = 0.104, X^2/*df ratio* = 1.075, *CFI* = 0.976, *GFI* = 0.946, *IFI* = 0.976, *TLI* = 0.968, *RMSEA* = 0.040) and accounted for 41% of the QoL variance. As figure 1 presents, PA positively affected PCS (0.20, p<0.01) and MCS (0.32, p<0.01), whereas PA negatively affected BP (-0.13, p<0.05). In turn, PCS and MCS positively influenced QoL (0.38, p<0.01 and 0.52, p<0.01, respectively). The total standardized effect of PA on QoL was 0.39, indicating that an increase of 1 standard deviation on PA predicts an increase of 0.39 standard deviations on QoL.

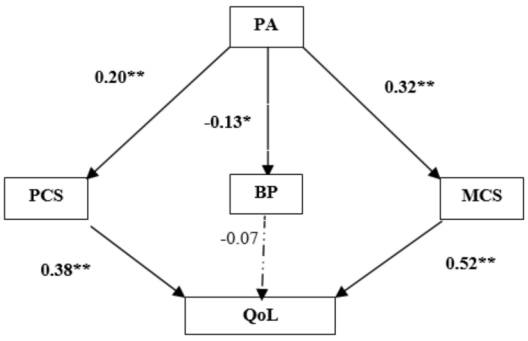

Fig. 1. Standardized estimates of the structural model in the group with LBP (n = 222).
Solid lines with standardized direct effects represent significant effects (** p < 0.01, * p < 0.05), whereas dashed lines with standardized direct effects represent insignificant effects. PA = physical activity; BP = bodily pain; PCS = physical component summary; MCS = mental component summary; QoL = quality of life.

Regarding the group without LBP, the model represented an acceptable fit (X^2 = 76.515, *df* = 70, p = 0.005, X^2/*df ratio* = 1.093, *CFI* = 0.949, *GFI* = 0.951, *IFI* = 0.949, *TLI* = 0.933, *RMSEA* = 0.055). The model accounted for 13% of the QoL variance. As figure 2 indicates, PA positively affected PCS (0.15, p<0.05) and MCS (0.66, p<0.01). MCS (0.46, p<0.01) positively affected QoL. The total standardized effect of PA on QoL was 0.12, indicating that an increase of 1 standard deviation on PA predicts an increase of 0.12 standard deviations on QoL.

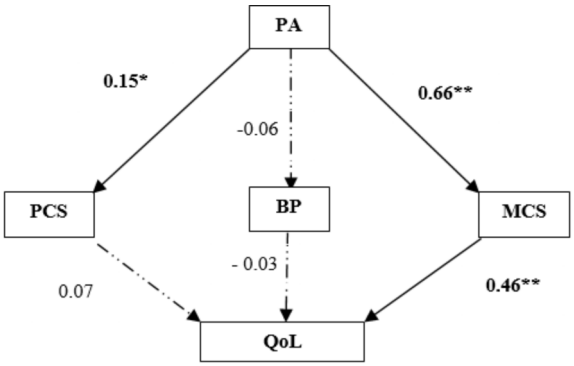

Fig. 2. Standardized estimates of the structural model in the group without LBP (n = 462).
Solid lines with standardized direct effects represent significant effects (** p < 0.01, * p < 0.05), whereas dashed lines with standardized direct effects represent insignificant effects. PA = physical activity; BP = bodily pain; PCS = physical component summary; MCS = mental component summary; QoL = quality of life.

Multiple Group SEM Analysis

Table 2 presents the results of the multiple group SEM analysis. The constrained model (2) was compared to unconstrained model (1) yielding a significant X^2_D value. In addition, the comparison between Models 4 and 1 indicated a significant X^2_D value, which was not verified for the comparison between Models 3 and 1.

Table 2 Fit indices of the multiple-group SEM analysis of the structural model across the two groups.

Model	X^2	*df*	X^2_D	df_D	p	*CFI*	*GFI*	*IFI*	*TLI*	*RMSEA*
1: unconstrained model	264.356, p=0.000	141	-	-	-	0.958	0.949	0.959	0.946	0.036
2: restricted regression weights	292.126, p=0.000	156	27.770	15	0.023	0.954	0.943	0.954	0.946	0.036
3: restricted covariance	265.795, p=0.000	142	1.439	1	0.230	0.958	0.949	0.959	0.946	0.036
4: restricted residuals	326.442, p=0.000	159	62.086	18	0.000	0.943	0.937	0.944	0.935	0.039

The Unconstrained model (1) was compared to constrained models (2, 3, 4).
X^2 = *chi-square* test; *df* = degrees of freedom; X^2_D = difference in X^2; df_D = difference in *df*; p = significance value; *CFI* = Comparative Fit Index; *GFI* = Goodness of Fit Index; *IFI* = Incremental Fit Index; *TLI* = Tucker and Lewis Index; *RMSEA* = Root Mean Square Error of Approximation.

DISCUSSION

The current study examined the causal relationships among PA, BP, health status and QoL in adults with and without LBP within the context of a theoretical framework. Such associations have not been reported so far in the literature. The results did not support the model's invariance across the groups and demonstrated that PA accounted for a medium amount of variance in QoL of individuals having LBP and a small amount of variance in QoL of individuals without LBP. In line with this, the findings indicated differences between the groups in the mediating effects of the relationship between PA and QoL that was assessed as satisfaction with one's life. A possible explanation for the differences found between the groups could be the fact that life satisfaction represents a differentiated multidimensional concept among people. Life satisfaction is associated with various factors moderated by personal value systems (McAuley & Morris, 2007). In other words, the PA and QoL association may be moderated by personal value systems that differ between individuals with and without LBP.

In particular, individuals who report LBP and participate in PA feel enhancing physical and psychological health status and QoL, as well as, reducing BP. Therefore, it seems that

individuals experiencing LBP participate in PA to reduce pain and improve their health, which may enhance their life satisfaction. These findings indicated the importance of health perceptions in cognitive judgment of QoL confirming the results of previous research (McAuley et al., 2008; Theodoropoulou et al., 2017). Therefore, specialists should focus on promoting PA that improves health to enhance QoL in individuals with LBP.

In contrast, the current study indicated that individuals who didn't report LBP and participate in PA feel improving psychological health status and promoting QoL. Therefore, it is possible that healthy individuals compared to adults with LBP differ in their cognitive judgement of QoL, participating in PA in order to improve psychological health, which enhances life satisfaction. This could be explained by the fact that satisfaction with one's life is highly associated with psychological health (McAuley & Morris, 2007). The aforementioned findings demonstrated that to improve QoL in healthy individuals PA interventions should be based on the promotion of psychological health. One of the ways to enhance psychological health is to increase self-efficacy and positive feelings during PA (McAuley & Morris, 2007).

Finally, this study had several limitations that need to be reported. First, its design was cross-sectional. Second, the instruments were self-reported. Third, LBP was recorded through self-reported response and not via physical examination. Despite the apparent limitations, this study had some advantages that should be considered. Particularly, a key feature of this study was the investigation of the PA and QoL relationship through the intermediary effects of BP and health in LBP that has not been examined until now. Further, the comparison of the theoretical model between the groups, the large sample size and the SEM analyses were original aspects of this research. Future longitudinal studies should be carried out for highlighting the interactions and relations of the examined variables over time.

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