European Journal of Sport Science, 2020
Vol. 20, No. 1, 17–23, https://doi.org/10.1080/17461391.2019.1606942

Testing the deconditioning hypothesis of low back pain: A study in 1182 older women

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Abstract
This study assessed the deconditioning hypothesis of low back pain (LBP) by examining physical function in relation to LBP and self-reported physical activity in women. This cross-sectional study recruited a representative population-based sample of females aged greater than 60 years. In total, 1182 women were included in the study and completed questionnaires (physical activity and LBP intensity) and functional testing (countermovement jump, chair rise, gait speed and grip strength). Individuals were stratified into four groups based on physical activity and LBP status and analysed via a two-way ANOVA. Most participants (87%) reported current LBP and 25% were physically active. Countermovement jump height, chair rise and grip strength were lower in physically inactive women ($p \leq 0.005$), but not women with LBP ($p \geq 0.21$). Gait speed was not associated with physical activity or LBP status. There was no association between LBP and physical activity status. Whilst LBP was associated with lower physical activity, contrary to the deconditioning hypothesis, LBP status itself was not associated with reduced physical function in community-dwelling women 60 years and older. This implies that LBP may not be related to physical function in this population group, but rather to their physical activity levels.

Keywords: *Exercise, walking speed, movement, aged*

Highlights

- LBP was not associated with physical activity status in women over the age of 60 years.
- Women over 60 years should endeavour to remain physically active to reduce the risk of physical deconditioning.
- Other factors outside of physical conditioning may play a role in the prevalence of LBP, while physical activity is important to reduce the risk of any possible consequences of LBP.

Introduction

Low back pain (LBP) is the leading cause of years lived with disability worldwide (Vos et al., 2012) and affects up to 84% of individuals over the lifespan (Balagué, Mannion, Pellisé, & Cedraschi, 2012). LBP is economically burdensome, directly costing both Belgium and Sweden greater than one billion euros annually (Dagenais, Caro, & Haldeman, 2008). Furthermore, those who retire early due to LBP-related disability have less total wealth than those who do not (75,981 vs 140,000 euros) (Schofield et al., 2011). In addition to economical costs, premature retirement is associated with up to 16% reduced physical function and therefore may exacerbate loss of independence (Dave, Rashad, & Spasojevic, 2006). Thus, LBP may in part explain reductions in physical function due to its association with disuse and deconditioning (Verbunt et al., 2003). Remaining physically active into older age may therefore be important to preserve physical function and avoid deconditioning (Dave et al., 2006; Verbunt et al., 2003).

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The deconditioning hypothesis is one postulating that physical inactivity and deconditioning (e.g. decreased muscle strength and cardiorespiratory fitness) leads to increased risk of developing LBP and therefore further reductions in physical function (Verbunt, Smeets, & Wittink, 2010). However, the validity deconditioning hypothesis is yet to be proven in research (Verbunt et al., 2010). A review by Griffin and colleagues (2012) showed that individuals with LBP undertook the same self-reported level of physical activity as healthy controls. However, when exploring a subsample of these studies, adults aged 65 years and older reported lower levels of physical activity due to LBP (Griffin, Harmon, & Kennedy, 2012; Koyanagi et al., 2017). Further supporting the deconditioning hypothesis, a subsequent meta-analysis added that lower levels of physical activity were related to greater physical disability in LBP (Lin et al., 2011). After menopause women have a 28% higher prevalence of LBP than their male counterparts (Wáng, Wáng, & Káplár, 2016). Therefore, understanding if women over 60 years with LBP have reduced physical function compared to those without LBP when physical-activity matched is important in determining causes of reduced physical function in this population (Fielding et al., 2011). The aim of the current study is to examine the effect of LBP on deconditioning by comparing measures of physical function in women over 60 years with and without LBP. We hypothesized that (a) a higher percentage of women over 60 years with LBP will be inactive compared to those without LBP and (b) when physical activity matched, older women with LBP will have similar results in countermovement jump, gait speed, chair rise and grip strength to those without LBP.

Materials and methods

This study was performed as a pre-planned secondary analysis of a wider 'Bustour' project (Belavý et al., 2016; Luhn, 2013) which recruited a representative population-based sample of women aged 60–95 years across Germany. A team from the Centre of Muscle and Bone Research toured 20 cities throughout Germany with all testing devices. Participants were recruited through local media outlets. Participants were excluded if they were unable to walk without an aid, had a diagnosed neuromuscular condition (e.g. polyneuropathy, Parkinson's disease, Guillain-Barre syndrome, stroke), osseous or cerebral metastatic tumours, severe lower limb arthritis, severe peripheral arterial disorders, lower limb poliomyelitis, previous bilateral hip replacement, prior fluoride therapy and severe spinal malformations including thoracic and lumbar scoliosis (> = Copp grade 3). The study was approved by the Charité University Medical School Berlin ethical committee (ek.207-21a). For the current study, ethical approval was provided by the Deakin University Human Research Ethics Committee (DUHREC; project number 2018-199). Prior to inclusion in the study, all participants provided informed written consent. This study aimed to recruit at least 180 women in each age range of 60–64, 65–70, 70–74, 75–79 and 80 or above years. In total, 1182 participants were included in the final sample with 947 participants completing all functional testing.

Intensity of LBP was measured using a visual analogue scale (VAS) (Mannion, Balagué, Pellisé, & Cedraschi, 2007). The VAS ranged from zero (no back pain) to ten (worst back pain) centimetres. Individuals were also dichotomised for back pain status: no (VAS = 0) and yes (VAS $\geq$ 1).

Physical activity status was assessed by participant-tester interview using the Sinaki physical activity risk score (Sinaki & Offord, 1988). Physical activity was rated from 0 to 6 in three domains: home, work and sport. Each domain was ranked from six as the lowest level of physical activity to zero being the highest level of physical activity. A total score was calculated out of 18 for physical activity levels. Physical activity status of individuals was also stratified from 0–6 as physically active and 7–18 as physically inactive.

Maximal countermovement jump was performed on a ground reaction force platform (Leonardo Mechanograph GRFP, Novotec GmbH, Pforzheim, Germany). Participants began the test standing on the 66 × 66 cm force platform with hands placed on their hips. The participant's body weight was measured prior to the first jump for calculations. Instructions were then provided on how to perform a countermovement jump with encouragement to jump as high as possible. The participants' hands remained on their hips throughout the test. Three jumps separated by one minute of rest were completed in total. Manufacturer software (Leonardo Mechanography version 2.01, Novotec GmbH, Pforzheim, Germany) was used for recording and storage of data. Maximal jump height (cm) was used for all analyses.

A chair rise was performed at a seated height of 45 cm. Participants were instructed to complete five repetitions from a seated-to-standing position as quickly as possible (Guralnik et al., 1994). Participants were required to cross their arms over their chest and come to complete hip and knee extension during each repetition. Tests were performed from a seated position which was attached to the ground reaction platform used for testing countermovement jump performance. The software used in countermovement jump testing measured the total duration of time required to perform five sit-to-stands (to two decimal places). The operator counted repetitions loudly, provided encouragement to the participant to complete the repetitions as quickly as possible and supervised the correct technique. The test was completed once, however, a test was stopped and repeated once if (a) the subject did not maintain the correct arm position or (b) the hip and knees did not complete full extension.

Gait speed was assessed using a 2.4 m walking test. Participants started behind a line and were instructed to walk the 2.4 m at a normal pace. Timing began when the participant started their initial movement from a standing start and was stopped when the participant crossed the 2.4 m line. Time to walk the 2.4 m course we recorded to the nearest 0.01 s using a digital stopwatch.

Grip strength was completed in a standing position using a digital hand-held dynamometer (Takei Scientific Instruments Co. Ltd., Tokyo, Japan). The elbow was placed in full extension with the shoulder in an adducted and neutrally rotated position (Incel et al., 2002). Three repetitions were completed on both the right and left hand with 30 s between tests. The highest value (kg) from the six tests was used for analysis.

Chi-square tests were used to determine associations between independent variables of LBP (yes/no) and physical activity (active/inactive) using SPSS version 25 (IBM, Armonk, NY, USA). A two-way ANOVA compared stratified groups of active with LBP, active without LBP, inactive with LBP and inactive without LBP for jump height, chair rise, gait speed and grip strength. Separate linear regression models were performed using Stata/SE version 15 (StataCorp, College Station, TX, USA) to predict physical function using VAS (0–10) and physical activity (0–18). All results were reported as mean ± standard deviation unless specified. An alpha-level of 0.05 was adopted for all other statistical tests.

Results

Table I displays the descriptive characteristics of the study participants. In total, 1025 (87%) of participants indicated they had LBP compared to 157 (13%) who did not. Of the physically active individuals, 244 (84%) had LBP compared to 48 (16%) without LBP. For physically inactive individuals, 781 (88%) reported they had LBP compared to 109 (12%) without LBP. No association was found between LBP and physical activity status (p = 0.067), with a two-way ANOVA showing no differences for groups on height, weight and body mass index (all, $p \geq 0.057$).

Results from the two-way ANOVA showed physical activity status ($p = 0.004$), but not LBP ($p = 0.54$), was related to countermovement jump height (Table II). There was no interaction between physical activity and LBP status ($p = 0.15$; Table II). A linear regression model with both dependent variables ($R^2 = 0.07$) showed physical activity level ($\beta = -0.34$, $p < 0.001$) and LBP intensity ($\beta = -0.12$, $p = 0.008$) were related to jump height (Figure 1).

For chair rise, a two-way ANOVA showed physical activity status ($p = 0.005$), but not LBP ($p = 0.287$) to be associated with chair rising time. There was no interaction between physical activity and LBP status for the chair rise test ($p = 0.193$; Table II). A linear regression ($R^2 = 0.06$) for both level of physical activity ($\beta = 0.28$, $p < 0.001$) and LBP intensity ($\beta = 0.19$, $p < 0.001$) had significant associations with chair rise performance (Figure 1).

When comparing all variables, a two-way ANOVA showed no association with LBP, physical activity status and gait speed (both, $p = 0.118$; Table II). A linear regression of both dependent variables ($R^2 = 0.00$) showed the level of LBP intensity ($\beta = -0.01$, $p = 0.013$) but not physical activity ($p = 0.106$) to be related to gait speed (Figure 1).

Grip strength was associated with physical activity status ($p = 0.002$), but not LBP ($p = 0.145$; Table II). There was no significant interaction between physical activity and LBP status ($p = 0.213$). Accounting for both dependent variables (R^2=0.06), a linear regression

Table I. Descriptive characteristics of the 1182 participants

	Total	Active + no LBP	Active + LBP	Inactive + no LBP	Inactive + LBP	p
Number, n (%)	1182 (100%)	48 (4.1%)	244 (20.6%)	109 (9.2%)	781 (66.1%)	0.067
Age (yrs)	72 ± 8	72 ± 7	71 ± 7	72 ± 8	73 ± 8	0.180
Height (cm)	158 ± 6	158 ± 6	159 ± 6	159 ± 6	158 ± 6	0.057
Body mass (kg)	68 ± 12	66 ± 11	68 ± 12	67 ± 10	68 ± 12	0.383
BMI (kg/m^2)	27 ± 4	26 ± 4	27 ± 4	27 ± 4	27 ± 4	0.936

Values are mean ± standard deviation unless specified; BMI, body mass index; LBP, low back pain, rated from 0 = no, 1–10 = yes; active = 0–6, inactive = 7–18 on the Sinaki physical activity risk score.

Table II. Results of a two-way ANOVA comparing back pain and physical activity levels on functional measures in community dwelling women over 60 years

	Active + no LBP	Active + LBP	Inactive + no LBP	Inactive + LBP	*p*-Value		
					LBP	PA	PA + LBP
Jump height (cm)	16.1 ± 4.2 (*N* = 44)	16.5 ± 4.4 (*N* = 234)	15.5 ± 4.1 (*N* = 100)	14.7 ± 4.2 (*N* = 684)	0.541	**0.004**	0.156
Chair rise (s)	9.3 ± 2.6 (*N* = 48)	9.2 ± 2.8 (*N* = 244)	9.8 ± 2.7 (*N* = 108)	10.7 ± 4.6 (*N* = 765)	0.287	**0.005**	0.193
Gait speed (s)	4.6 ± 1.5 (*N* = 47)	4.8 ± 1.6 (*N* = 241)	4.7 ± 2.0 (*N* = 109)	5.1 ± 2.0 (*N* = 773)	0.118	0.247	0.737
Grip strength (kg)	24.8 ± 4.6 (*N* = 48)	24.7 ± 4.8 (*N* = 244)	24.0 ± 5.1 (*N* = 108)	22.7 ± 5.1 (*N* = 778)	0.145	**0.002**	0.213

Values are mean ± standard deviation unless specified. Results were analysed using a two-way ANOVA to account for the LBP and physical activity status of individuals. Missing data were removed from analysis. LBP, low back pain, rated from VAS 0 = no, 1–10 = yes; PA, physical activity; active = 0–6, inactive = 7–18 on the Sinaki physical activity risk score.

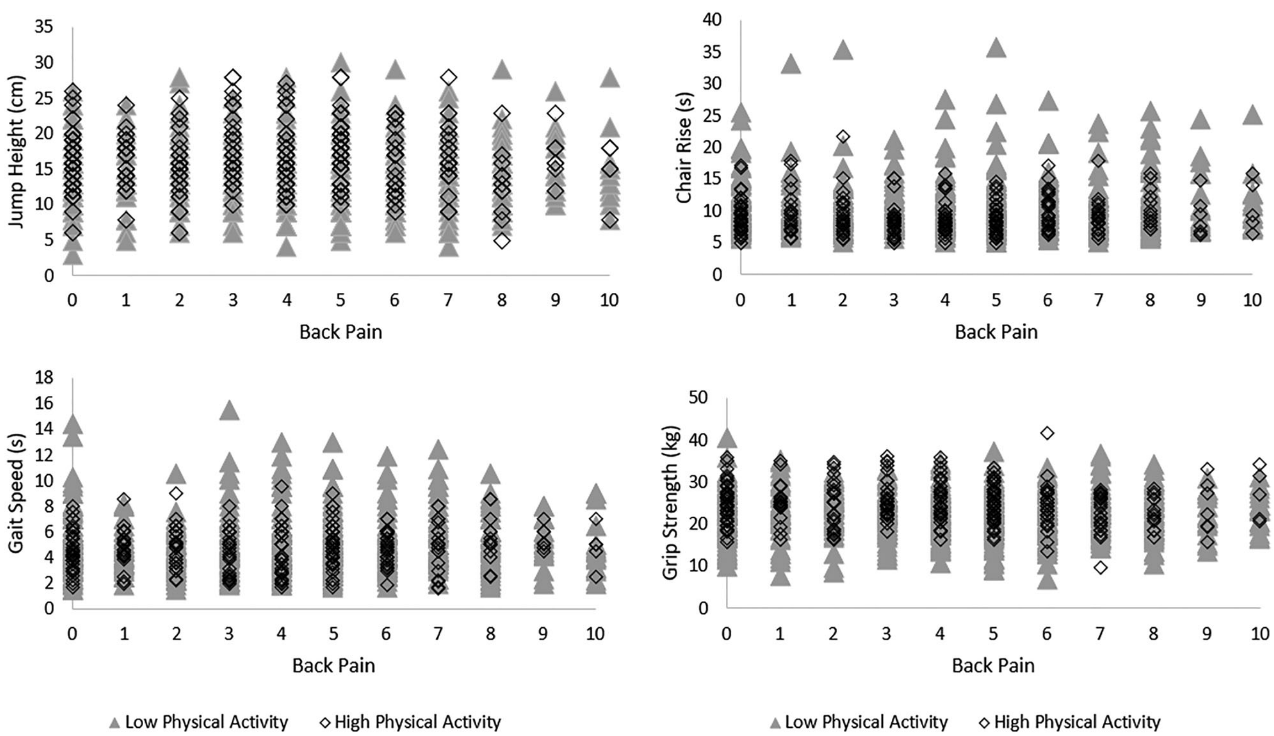

Figure 1. Scatter plots of LBP and physical activity status on jump height (cm), chair rise (s), gait speed (s) and grip strength (kg) performance. Individuals were stratified as 0–6 as high physical activity and 7–18 as low physical activity. Back pain intensity measured on the visual analogue scale with zero as no back pain to ten as severe back pain.

showed that level of physical activity ($\beta = -0.35$, $p < 0.001$) and LBP ($\beta = -0.15$, $p = 0.006$) to be associated with grip strength performance (Figure 1).

Discussion

The major findings of the current study were that self-reported physical activity, rather than the presence of LBP, was associated with reduced physical function in women over 60 years. The results of the current study also show that a larger percentage in the cohort with LBP were less physically active than those without LBP, however, this was not statistically significant. When physical function tests of countermovement jump, chair rise and grip strength considered physical activity and LBP status, the results showed that physical activity status, but not LBP, is more strongly associated with reduced physical function.

The deconditioning hypothesis suggests physical inactivity and reductions in physical function cause LBP, which subsequently leads to further reductions in activity and function (Verbunt et al., 2010). The results of the current study showed that physical activity status in women over 60 years is more associated with reductions in physical function, rather than the presence of LBP, which is contrary to prior research. Firstly, Basler et al. (2008) reported that self-reported function was significantly lower in older adults with LBP than those without LBP. However, self-perception of function does not correlate 1:1 ($r < 0.40$) with objectively measured function (Brouwer et al., 2005). Rudy, Weiner, Lieber, Slaboda, and Boston (2007) demonstrated that both self-reported and objective measures of physical function (chair rise and gait speed) to be lower in older adults with LBP than those without LBP. However, a limitation of the above studies is that neither compared self-reported and objective functional outcomes based on physical activity status. Our study addressed this limitation and highlighted that when physical activity status is considered, there were no differences in objective functional measures in women over 60 years with and without LBP. Therefore, women over 60 years should endeavour to remain physically active as this may help avoid decrements in function in the presence of LBP (Searle, Spink, Ho, & Chuter, 2015).

Chimenti, Scholtes, and Van Dillen (2013) showed that individuals who participate in regular rotation sports (e.g. tennis and golf), but had lower leisure-time physical activity compared to matched controls, had an increased prevalence of LBP. Therefore, it is unlikely that deconditioning can explain all cases of LBP (Chimenti et al., 2013). It has been suggested that physical activity may provide analgesic benefits outside of improving function that could ultimately reduce pain intensity, such as increasing anti-inflammatory cytokines and endogenous opioids which reduce nociceptive and neuropathic pain processes (Chimenti, Frey-Law, & Sluka, 2018). Hence, promoting strategies to remain physically active in those with LBP may not only be important to reduce physical function decrements in women over 60 years but also promote analgesia and reductions in pain intensity (Chimenti et al., 2018).

It is appropriate to consider the limitations of the current study. Firstly, the cross-sectional nature means cause and effect between LBP, physical activity and deconditioning cannot be dismissed. Furthermore, the duration of LBP was not tracked in the current study. A previous meta-analysis has demonstrated duration of LBP to associate with the level of physical activity and disability (Lin et al., 2011). Therefore, it is unknown whether the duration of LBP could influence the results of the current study. Furthermore, there was no familiarisation for countermovement jump testing, which can improve results through learning (Farias et al., 2013). However, due to the large sample size, we do not expect this to influence the results. Lastly, the participants in this study may not quite reflect a true sample of women over the age of 65 due to the high presence of LBP compared to general population data (Hartvigsen et al., 2018). However, it is possible that women with LBP were more likely to self-enrol due to other spine-related outcomes of the wider study (Belavý et al., 2016; Luhn, 2013), and potentially explains the higher prevalence of LBP observed. This may also highlight the trend towards significance between LBP and physical activity. Despite this, even if LBP is related to physical capacity, our findings show the size of the effect of LBP on physical performance is small in comparison to the role of physical activity.

Based on the limitations of the current study, future research should endeavour to provide longitudinal evidence to show the relationship between LBP, physical activity and physical function. Longitudinal studies may provide important evidence to help determine causality between LBP and physical activity, as reverse causality cannot be eliminated from the current study. Understanding causality will assist with developing appropriate interventions to assist with reducing the burden of LBP. Further research should also aim to identify and address barriers preventing women over 60 years engaging in regular physical activity to reduce decrements of physical function in this population.

Conclusions

In line with the deconditioning hypothesis, LBP may be associated with reductions in self-reported physical activity, however, the results of the current study show that physical activity status had a greater association with reductions physical function in women over 60 years when compared to LBP status. Therefore, women over 60 years should endeavour to remain physically active to reduce the risk of physical deconditioning. This study recommends increasing physical activity in women over 60 years, whether related to LBP or not, is important to preserve physical function.

Acknowledgements

The authors wish to thank all the participants of the study. *Contributors*: ST – Statistical analysis, preparation of manuscript; GA – Conception and design

of experiments, data collection, revision of manuscript ;CM – Conception and design of experiments, revision of manuscript; PO – Statistical analysis, revision on manuscript; NM – Statistical analysis, revision of manuscript; FT – Data collection, revision of manuscript; DF – Conception and design of experiments, secured funding, conception and design of experiments; DB – Conception and design of experiments, revision, conception and design of manuscript.

Funding

The "bustour" study was supported by the Kuratorium Knochengesundheit (Sinsheim, Germany) and institutional funds.

Disclosure statement

No potential conflict of interest was reported by the authors.

Ethics approval

The study was originally approved by the Charité University Medical School Berlin ethical committee (ek.207-21a). For secondary analysis, ethical approval was provided by the Deakin University Human Research Ethics Committee (DUHREC; project number 2018-199).

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