Comparison of Physical Fitness between Rice Farmers with and without Chronic Low Back Pain: A Cross-Sectional Study

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Objective: *To compare physical fitness between rice farmers with chronic low back pain (CLBP) and a healthy control group.*
Material and Method: *Sixty-eight rice farmers with CLBP were matched according to age and sex with healthy farmers. All subjects underwent nine physical fitness tests for body composition, lifting capacity, static back extensor endurance, leg strength, static abdominal endurance, handgrip strength, hamstring flexibility, posterior leg and back muscles flexibility and abdominal flexibility.*
Results: *There was no significant difference between CLBP and healthy groups for all tests, except the static back extensor endurance. The back extensor endurance times of the CLBP group was significantly lower than that of the control group (p = 0.002).*
Conclusion: *Static back extensor endurance is the deficient physical fitness in CLBP rice farmers. Back extensor endurance training should be emphasized in both prevention and rehabilitation programs.*

Keywords: *Physical fitness, Back pain, Endurance, Farmer, Exercise*

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In Thailand, there are about 16 million rice farmers from 66 million inhabitants (Office of Agricultural Economics 2007/2008). Although the prevalence of low back pain (LBP) among rice farmers has not been estimated, farmers have the most prevalence of LBP when compared with other manual workers due to more physical exertion[1,2]. Rice farmers with LBP are probably at risk of developing chronic low back pain (CLBP) because they are likely to work when injured. In addition, most of them are poor and cannot afford to be off work and lack workers' compensation.

Exercise therapy has been widely recommended for decreasing pain and improving function in adults with CLBP[3,4]. Information regarding physical fitness is very useful to design a suitable exercise program for patients with CLBP. Previous studies demonstrated that patients with CLBP showed decreased muscular strength[5-9] and endurance in trunk muscles, especially in back extensor muscles[10-12], as well as in leg muscles[8]. They also had reduced flexibility of back muscles and hamstrings when compared to normal subjects[13-17]. The literature review has reported that obesity or high BMI (>30 kg/m^2) was associated with LBP and disability in general workers[18], and such association was stronger in women than in men. However, most studies were carried out with general workers and patients in clinical settings whose occupations were not identified. Physical fitness of rice farmers with CLBP has not been investigated. Thus, the present study aimed to compare physical fitness of rice farmers with and without CLBP. Its results could guide practitioners and health personnel in communities to design appropriate exercises or fitness programs for rice farmers with CLBP.

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Material and Method

Subjects

Two hundred and one rice farmers aged between 30-72 years who had been living in

Wangnamkhu subdistrict, Meung district, Phitsanulok, Thailand and growing at least two crops of rice per year for longer than one year volunteered for the present study. Inclusion criteria for the CLBP group were experiencing LBP for longer than three months, having pain score equal to or less than 5/10 and no radiating pain and numbness in the legs. For the non-LBP group (NLBP), they had no LBP during the study period, no previous history of LBP or having a history of LBP in the past 1-2 years without any change in activities. Farmers with other musculoskeletal problems, obvious abnormal posture such as scoliosis, spinal surgery, symptomatic heart disease, asthma, uncontrolled hypertension were excluded. The farmers were also excluded if they could not complete the tests or experienced significantly increased pain in low back during testing.

CLBP rice farmers were matched with the NLBP group according to age and sex. Both groups were interviewed for age, general health problems, assessed for abnormal posture using postural grid and plumb line and measured body weight, height and blood pressure. Ethical approval for the present study was granted by the Ethical Committee on Research Involving Human Subjects, Naresuan University.

Procedure

The farmers who met inclusion criteria signed an approved informed consent prior to participation. All farmers were tested for body fat percentage, lifting capacity, static back extensor endurance, leg strength, static abdominal endurance, handgrip strength, hamstring flexibility, posterior leg and back muscles flexibility, and abdominal flexibility, respectively. The 2-minute interval between each test was required.

Measurement of body fat percentage

Body fat percentage was measured using Tanita Body Fat Analyzer (TBF 531). Tester digitally set the Tanita equipment by entering the subject's age, gender, and height. The subject was instructed to stand statically on the Tanita. The Tanita reported body fat percentage on screen within 10 seconds.

Lifting test

Each subject was required to lift a wooden box that weighed 10 kg up to his/her waist by bending both knees, keeping low back straight and carrying the box close to the trunk as much as possible. The tester gradually put weight into the box, for women with the increment of 5 kg but for men with the increment of 10 kg. If the farmer could lift more weight, the tester could put more weight into the box at the subject's request. For safety reasons, the subject was allowed to lift only five times and the total weight was no more than 50 kg. The test was also ended if the subject started to experience increased pain in his/her low back. The highest weight lifted (in kg) was recorded.

Static back extensor endurance test

Static back extensor endurance test is the modified Biering-Sorensen test described by McGill et al[9]. The subject lay prone with the lower body fixed tightly to the test bench at the ankles, knees, thighs, and hips with the anterior superior iliac spines placed at the edge of the test bench and supported upper body with both hands against the floor (Fig. 1a). The lower end of the adjustable stick was placed on the middle of the subject's back (at about T7) to control trunk position. The exertion began with the upper limbs held across the chest with hands resting on the opposite shoulders. At the same time the subject's upper body was held statically and horizontally on the space without any support as long as possible (Fig. 1b). The endurance time was recorded in seconds with a stopwatch from the point at which the subject assumed the horizontal position until the upper body came out of contact with the metal stick.

Leg strength test

The subject stood on a platform attached to the Back-Leg dynamometer. The dynamometer was attached to a chain linked with a bar. The subject squatted down until knee angles were approximately 130 degrees and held the bar with straight arms and palms facing down. During exertion, the subject pulled the bar up by extending his/her legs with consistent and forceful manner. This maneuver was repeated two times, the highest score (in kg) was used for data analysis.

Fig. 1 Static back extensor endurance test (a) starting position (b) testing position

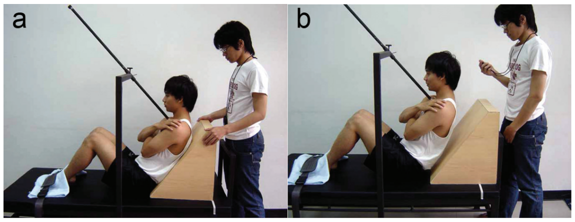

Fig. 2 Static abdominal endurance test (a) starting position (b) testing position

Static abdominal endurance test

Static abdominal endurance test is modified from the flexor endurance test described by McGill et al[19]. The subject sat on a test bench and laid the upper body on a support wedge with an angle of 50 degrees from the test bench (Fig. 2a). Both knees and hips were flexed to 90 degrees. The subject folded both arms across the chest with the hands placed on the opposite shoulder and toes fixed under toe straps. The lower end of the adjustable stick was placed at the subject's jugular notch. At the beginning of the test, the subject was instructed to remain in the same position while the supporting wedge was pulled back 10 cm (Fig. 2b). The endurance time was recorded in seconds from the point at which the subject's back was off the support until the jugular notch come out of contact with the end of the stick.

Measurement of handgrip strength

Handgrip strength was measured by Biometric E-link digital handgrip dynamometer in the standing position. The subject held the handgrip dynamometer parallel to the side of the body with elbow fully extended and wrist slightly extended. The subject was required to squeeze the handgrip dynamometer as hard as possible. The grip strength was recorded in kilograms. The test was repeated three times for each hand. The highest of the three readings was taken.

Straight leg raise test for hamstrings flexibility

The subject lay on his/her back on a test bed. The non-dominant leg was firmly fixed to the bed by a towel and belt. The test was only performed on the dominant leg. The fulcrum of the digital goniometer was placed at the lateral aspect of the subject's greater trochanter with the stationary arm parallel to the subject's trunk and the moveable arm along the lateral aspect of the thigh. While keeping the knee fully extended, the assistant tester passively elevated the subject's leg as high as possible to the point that the knee started to bend. The hip range of motion was recorded. The test was repeated three times and the maximum range (in degree) was used.

Sit and reach test

Sit and reach (SR) test was used to measure flexibility of the posterior leg and low back musculature. A SR box was placed on the floor. The subject sat on the floor with both legs fully extended and with the soles of the feet against the box. The subject was requested to slowly reach forward with parallel hands as far as possible without bending the knees. The score was the most distance point in centimeters (cm) reached with fingertips. The best of three trials was recorded.

Abdominal flexibility

Abdominal flexibility was measured using a backward fleximeter (T.K.K. 5004 Extension A). The subject lay prone on the floor with hands clasped on the back. While an assistant tester pressed the subject's feet on the floor, the subject was instructed to slowly raise the upper body as high as possible. The vertical distance from the floor to the lower surface of his/her chin was measured by the backward fleximeter. The test was repeated three times and the best distance (in cm) was used.

Reliability study

Before data collection, each tester was assessed for intra-rater reliability for each physical fitness test using test-retest method. Twenty subjects with a mean age of 27 ± 10.53 years were recruited for the present study. Of 20 subjects, twelve were normal, six had current LBP at the study period, and two had a history of LBP. They underwent nine physical fitness tests. Each test was performed by a well-trained senior physiotherapy student. It was repeated by the same physiotherapy student after two days. The intra-class correlation coefficients (ICC) of test-retest reliability were analyzed. The results were highly acceptable (ICC $\geq$ 0.80) for all physical fitness tests.

Data analysis

The results were reported as means $\pm$ SD. Distribution of all data was tested by one sample Kolmogorov-Smirnov Goodness of fit test. Independent t-test was used to assess whether the two groups were similar regarding age, weight, height, BMI. Then, paired t-test and Wilcoxon signed-ranks test were used to compare physical fitness between the CLBP and the NLBP groups. Statistical significance was defined as p less than 0.05.

Results

Sixty-eight CLBP farmers were matched with NLBP farmers based on age and sex. Sixty-five subjects were excluded from the present study. Twenty-two subjects were excluded due to pain in other body parts and one subject had severe scoliosis. Twenty subjects had conditions, *i.e.* heart diseases, uncontrolled hypertension, and asthma, which limited the tests. Ten subjects refused to continue the tests because they did not have enough time to complete all tests. Six subjects discontinued the tests because they experienced significantly increased pain in their low back. Lastly, six subjects were excluded because they could not be matched.

Characteristics of subjects

Each group consisted of thirty-nine females and twenty-nine males. Physical characteristics of CLBP and NLBP groups are presented in Table 1. Age, weight, height, and BMI were compared. No significant differences were found between the two groups ($p > 0.05$). Thus, the two groups were similar and well matched.

Table 1. Characteristics of CLBP and NLBP groups

Variable	CLBP group (n = 68) (mean ± SD)	NLBP group (n = 68) (mean ± SD)	p-value
Age (years)	49.50 ± 8.15	52.24 ± 8.17	0.053
Weight (kg)	62.17 ± 11.00	60.50 ± 9.18	0.339
Height (m)	1.57 ± 0.08	1.59 ± 0.07	0.196
BMI (kg/m^2)	25.13 ± 3.88	24.00 ± 3.44	0.072

Test by independent t-test

Comparison of physical fitness

The values of all physical fitness tests presented in Table 2 and 3 were compared. The results showed no differences in all physical fitness values between the CLBP group and the NLBP group, except the static back extensor endurance. The static back extensor endurance times of the CLBP group were significantly lower than those of the NLBP group ($p = 0.002$). Further analysis by comparing abdominal and back extensor endurance ratio (Abd/Back En) between the two groups revealed that Abd/Back En of the CLBP group was significantly greater than that of the NLBP group ($p < 0.001$) as presented in Table 3.

Discussion

In the present study, all physical fitness values in the CLBP group and the NLBP group showed no difference, except the static back extensor endurance. The back extensor endurance times of the CLBP group (89.7 ± 30.6 sec) were significantly less than those of the NLBP group (108.5 ± 38.8 sec). While the back extensor endurance in CLBP rice farmers was decreasing, the abdominal endurance in the CLBP group was maintaining. The result of the present study showed that the average endurance times of abdominal muscles were 122.3 ± 58.2 sec in CLBP rice farmers and 107.7 ± 44.4 sec in normal farmers, which were not different. It was noted that endurance times

Table 2. Comparisons of mean and standard deviation of outcomes of physical fitness tests between CLBP and NLBP groups

Physical Fitness	CLBP group (n = 68) (mean ± SD)	NLBP group (n = 68) (mean ± SD)	p-value
% body fat	30.51 ± 9.72	27.99 ± 9.63	0.137
Static back endurance (sec)	89.69 ± 30.63	108.53 ± 38.80	0.002*
Leg strength (kg)	117.65 ± 41.14	120.22 ± 36.28	0.710
Hand grip strength (kg)	32.89 ± 9.04	33.10 ± 7.72	0.897
Static abdominal endurance (sec)	122.32 ± 58.20	107.73 ± 44.39	0.081
Hamstrings flexibility (degree)	90.36 ± 10.41	89.15 ± 8.17	0.450
SR flexibility (cm)	16.93 ± 6.19	15.52 ± 6.92	0.219
Abdominal flexibility (cm)	34.03 ± 6.00	33.97 ± 6.43	0.958

Test by paired t-test
* Significant difference p-value < 0.01

Table 3. Comparisons of lifting capacity and abdominal and back extensor endurance ratio between CLBP and NLBP groups

Physical fitness	CLBP group (n = 68) Median (Q1, Q3)	NLBP group (n = 68) Median (Q1, Q3)	p-value
Lifting capacity (kg)	30.00 (20.00, 40.00)	30.00 (25.00, 39.38)	0.435
Abd/Back En	1.29 (0.93, 1.76)	0.98 (0.72, 1.29)	0.001*

Test by Wilcoxon signed-ranks test
Abd/Back En = abdominal and back extensor endurance ratio; Q = quartile
* Significant difference p-value < 0.01

of both back extensors and abdominal muscles in normal farmers were not different from the values of a normal Thai general population reported by Taechasubamorn et al[20].

Back extensor endurance has been reported to be equal to or greater than abdominal endurance in normal subjects because the back extensor muscles are working against gravity[20,21]. In contrast, the result of the present study revealed that the static back extensor endurance times were lower than the static abdominal endurance times in the CLBP group as presented in Table 2. Consequently, the abdominal/ back extensor endurance ratio in the CLBP group was greater than 1.0. McGill (21) suggested that the abdominal/back extensor endurance ratio being greater than 1 indicated an imbalance of trunk muscles that may be found in CLBP patients. The results of the present study have confirmed the results of McGill's study. The median of abdominal and back extensor endurance ratio in the CLBP group was significantly higher than that of the NLBP group ($p < 0.001$) and the value was equal to 1.3 and 1.0, respectively (Table 3).

The maintenance of abdominal endurance may relate to rice farming activities, which required more exertion of abdominal muscles, for example prolonged holding and pressing the handles of a ploughing machine or carrying heavy pesticide sprayer on the farmers' back. The decreased back extensor endurance could be explained as a result of prolonged LBP. The back muscles may be prone to injury more than abdominal muscles from over stretching because rice farmers might have more activities in bending forward and lifting heavy objects. With repetitive and accumulative trauma to the back muscles, it may cause fibrosis and vascular change in back muscles resulting in decreased back muscles endurance. However, these explanations may need to be proven by future research.

Some authors reported that trunk muscle strength was significantly lower in CLBP patients compared with healthy individuals without LBP[8,9]. However, the change in trunk muscle strength cannot be concluded among rice farmers in the present study. This is the limitation of this present study because the strength measurements (lifting test and leg strength test) used in the present study might not directly measure trunk muscle strength, although these tests are simple and feasible to be used as field tests in a primary health care unit. Future research should aim to investigate trunk muscle strength in CLBP rice farmers and use more direct measurement.

Clinical implication and future study

The present study proved that back extensor endurance was the only lacking physical fitness in CLBP rice farmers. Exercises for improving back extensor endurance should be encouraged in prevention and rehabilitation programs for CLBP rice farmers. Both practitioners and health personnel at primary level should pay attention to measurement of abdominal and back extensor endurance times and their ratio in CLBP rice farmers for evaluation and for training target.

Since the present study is cross-sectional and cannot reflect causal relationship of decreased back extensor endurance and CLBP, future research should focus on a cohort study to investigate this relationship. In addition, future research should emphasize on evaluation of the effectiveness of specific back exercise program for CLBP rice farmers.

Conclusion

Static back extensor endurance is the only deficient physical fitness among CLBP rice farmers. Endurance training of back extensors should be emphasized in both prevention and rehabilitation programs for CLBP rice farmers rather than abdominal muscles.

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การเปรียบเทียบสมรรถภาพกายระหว่างชาวนาปลูกข้าว ที่มีกับไม่มีปัญหาปวดหลังส่วนล่างเรื้อรัง: การศึกษาแบบตัดขวาง

ปนดา เตชทรัพย์อมร, ทวีศักดิ์ นพเกษร, ศุภสิทธิ์ พรรณารุโณทัย

***วัตถุประสงค์**: เพื่อเปรียบเทียบสมรรถภาพกายของชาวนาปลูกข้าว ที่มีอาการปวดหลังส่วนล่างเรื้อรังกับกลุ่มควบคุมที่มีสุขภาพดี*

***วัสดุและวิธีการ**: ใช้วิธีการจับคู่ชาวนาปลูกข้าวที่มีปัญหาปวดหลังส่วนล่างเรื้อรังจำนวน 68 คน กับชาวนาที่ไม่ปวดหลัง โดยพิจารณาจากอายุ และเพศ โดยชาวนาแต่ละคนจะได้รับการวัดสมรรถภาพกาย 9 อย่าง ได้แก่ เปอร์เซ็นต์ไขมันในร่างกาย ความสามารถในการยก ความทนทานของกล้ามเนื้อเหยียดหลังแบบอยู่กับที่ ความแข็งแรงของกล้ามเนื้อขา ความทนทานของกล้ามเนื้อหน้าท้องแบบอยู่กับที่ แรงบีบมือ ความยืดหยุ่นของกล้ามเนื้อแฮมสตริงส์ ความยืดหยุ่นของกล้ามเนื้อหลัง และกล้ามเนื้อหลังขา และความยืดหยุ่นของกล้ามเนื้อหน้าท้อง ตามลำดับ*

***ผลการศึกษา**: ไม่พบความแตกต่างของสมรรถภาพกายระหว่างกลุ่มชาวนาที่ปวดหลังส่วนล่างเรื้อรัง กับกลุ่มที่ไม่ปวดหลัง ยกเว้นความทนทานของกล้ามเนื้อเหยียดหลังแบบอยู่กับที่ ซึ่งพบว่า ความทนทานของกล้ามเนื้อเหยียดหลังแบบอยู่กับที่ในกลุ่มที่ปวดหลังส่วนล่างเรื้อรังมีค่าน้อยกว่าในกลุ่มที่ไม่ปวดหลัง อย่างมีนัยสำคัญทางสถิติ ($p < 0.002$)*

***สรุป**: ความทนทานของกล้ามเนื้อเหยียดหลังแบบอยู่กับที่เป็นสมรรถภาพกายเดียวที่ลดลง ในชาวนาปลูกข้าวที่มีปัญหาปวดหลังส่วนล่างเรื้อรัง ดังนั้นในโปรแกรมการป้องกัน และการฟื้นฟูสมรรถภาพสำหรับชาวนาปลูกข้าวที่มีปัญหาปวดหลังเรื้อรังควรเน้นการฝึกความทนทานในกล้ามเนื้อเหยียดหลัง*