

# Effects of Kinesio Taping Applied to Diaphragm Muscle on Aerobic Exercise Capacity and Pulmonary Function in Sedentary Individuals

## *Sedanter Bireylerde Diyaframa Uygulanan Kinezyo Bantlamanın Aerobik Performansa ve Solunum Fonksiyonlarına Etkileri*

### Abstract

**Aim:** In this study, we aimed to determine the short-term effects of diaphragmatic Kinesio taping (KT) on aerobic exercise capacity and pulmonary function in sedentary individuals.

**Materials and Methods:** Sedentary volunteers were included in the study. Participants were randomly divided into two groups: KT group (n =17), and sham KT group (n=19). In order to evaluate submaximal functional capacity and aerobic performance, shuttle run and pulmonary function tests were performed for each participant both prior to and four days after KT. Chest circumference measurement was made for the flexibility of the rib cage. The KT muscle facilitation technique was applied to the diaphragm muscle.

**Results:** Pulmonary function test values showed an increase in FEV1 four days after KT, compared to the values prior to KT (p=0.002). There was statistically significant difference between shuttle run test results (p=0.001) and axillar chest circumference measurements (p=0.045) before and 1 week after KT. Statistically significant difference was also observed concerning FEV1 (p=0.014), FEV1/FVC (p=0.035) results and shuttle run test distance (p=0.009).

**Discussion and Conclusion:** KT applied to the diaphragm muscle improves aerobic performance and pulmonary functions in the short term and when compared to the sham KT group.

**Keywords:** exercise performance; sedentary; respiratory; Kinesio taping

### Öz

**Amaç:** Çalışmamızda sedanter bireylerde diyaframa uygulanan Kinezyo bantlamanın (KB) kısa vadede aerobik performans ve solunum fonksiyonları üzerindeki etkilerini belirlemeyi amaçladık.

**Gereç ve Yöntemler:** Sedanter gönüllü bireyler çalışmaya dahil edildi. Katılımcılar rastgele iki gruba ayrıldı: KB grubu (n=17) ve sham KB grubu (n=19) grubu. Submaksimal fonksiyonel kapasite ve aerobik performansı değerlendirmek için her katılımcıya KB'den önce ve 4 gün sonra mekik koşu ve solunum fonksiyon testleri uygulandı. Göğüs kafesinin esnekliği için göğüs çevre ölçümü yapıldı. Diyafram kasına Kinezyo bantlama kas fasilitasyon tekniği uygulandı.

**Bulgular:** KB öncesindeki ve 4 gün sonrasındaki pulmoner fonksiyon test sonuçları karşılaştırıldığında FEV1 değerlerinde artış görüldü (p=0,002). KB öncesindeki ve 4 gün sonrasındaki mekik koşu testi sonuçları (p=0,001) ve aksiller göğüs çevresi ölçümleri (p=0,045) arasında istatistiksel olarak anlamlı fark vardı. Gruplar karşılaştırıldığında FEV1 (p=0,014), FEV1/FVC (p=0,035) değerlerinde ve mekik koşu testi mesafesinde (p=0,009) istatistiksel olarak anlamlı fark gözlemlendi.

**Tartışma ve Sonuç:** Kısa vadede ve yalancı KB ile karşılaştırıldığında diyafram kasına uygulanan KB aerobik performansı ve solunum fonksiyonlarını pekiştirmiştir.

**Anahtar Sözcükler:** egzersiz performansı; sedanter; respiratuvar; Kinezyo bantlama

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## INTRODUCTION

The most important function of the respiratory system is gas exchange. Adequacy of gas exchange is closely related to the mechanical properties of the respiratory pump. Functionality of the respiratory pump is associated with the interaction of the lungs, abdominal wall and chest wall that is formed by ribs, intercostal muscles, and diaphragm wall. Diaphragm muscle is the most important component of this pump, undertaking 75% of the inspiratory work.

Inspiratory capacity decreases markedly in case of functional loss in the diaphragm. Thus, in respiratory system diseases that impair the diaphragmatic muscle structure, such as chronic obstructive pulmonary disease (COPD), asthma, and neuromuscular diseases, increasing the functionality of this structure can help resolve the patient's symptoms and provide significant improvement in pulmonary function test scores (1–4).

Kinesio taping (KT), developed by Dr. Kenzo Kase in 1973, is a special taping technique frequently used in recent years. Used primarily in musculoskeletal disorders, it has a very broad area of application and is also utilized in non-musculoskeletal disorders. The cotton taping material is latex-free and thin, its air and moisture permeability precluding skin irritation. It is designed so as to reflect the characteristics of the skin. Its thickness matches the epidermis layer, and its flexibility is similar to the elasticity of the human skin. It can stretch up to 55–60% of its length and thereby adjust to stress and relaxation of the skin during movement. The tapes can remain on the application area even after wetting and sweating, for 3 to 7 days depending on the structure of the skin and ambient conditions (5).

Although the underlying mechanism of effect of KT is unknown, it has been reported in the literature to be used to support the weak muscles by muscle facilitation or inhibition, increase lymphatic fluid and blood circulation, reduce pain by stimulating the neurological system, provide proprioceptive input, and correct the misalignment of the joints (6–8). The mechanism of effect of KT in increasing the muscular strength depends on the application technique. Depending on the technique, muscle activation may be both improved and inhibited. The underlying mechanism is explained with the stimulation of the sensory motor and proprioceptive systems (5).

The literature appears to contain a limited number of studies investigating the effects of KT on the respiratory muscles. Therefore, in this study we aimed to determine the short-term effects of diaphragmatic KT on aerobic exercise capacity and pulmonary functions in sedentary individuals.

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## MATERIALS AND METHODS

Thirty six healthy sedentary volunteers aged 18 to 25 years were included. The participants were randomly divided into two groups based on the treatment they received: the Kinesio taping group (n =17) and the sham KT group (n=19). Potential participants were excluded if they had smoked and suffered problems in their musculoskeletal, cardiopulmonary, metabolic and other systems that might affect their physical performance during the study. Also 2 participants were excluded from the KT group because of allergic reaction to the taping material. The study was approved by the University Ethical Committee (Kırıkkale University Clinical Research Ethical Committee; chairperson Mehmet Savas Ekici, MD, Prof.; protocol number 05/05; date of approval 23/2/2016), and all participants gave written informed consent. All patients were assessed by an experienced physiotherapist, and the treatments were performed by another experienced physiotherapist in order for a single blind structure in the study. The patients were randomly assigned to one of the two groups using an online random allocation software program (GraphPad Software QuickCalcs, GraphPad Software Inc., La Jolla, CA, USA).

Sociodemographic characteristics (age, height, weight, body mass index, education, exercise, and smoking history and habits) of the participants were recorded. They were asked if they had had exercising habits, such as exercising for 30–45 minutes at least 3 days a week for at least 3 months. In order to evaluate submaximal functional capacity and aerobic performance, shuttle run and pulmonary function tests were performed for each participant both prior to and on the fourth day after taping. Measurements were performed by using spirometry (BTL-08 Spiro Pro system, Germany) in the sitting position. Measurements were carried out in accordance with the American Thoracic

**Table 1.** Sociodemographic characteristics of participants (X±SD)

	KT (n=17)	Sham KT (n=19)	P
<b>Age (years)</b>	21.64±1.16	20.78±2.39	0.189 <sup>†</sup>
<b>BMI (kg/m<sup>2</sup>)</b>	22.06±2.37 <sup>†</sup>	21.31±2.40	0.334 <sup>†</sup>
<b>Sex (%)</b>			0.881 <sup>††</sup>
Female	14 (82.4)	16 (84.2)	
Male	3 (17.6) <sup>††</sup>	3 (15.8)	

<sup>†</sup> Mann-Whitney U test; <sup>††</sup> chi-square test; BMI: body mass index

**Table 2.** Measured values before and one week after KT

	Before taping	One week after KT	P
<b>Axillar (cm)</b>	5.53±1.85	5.80±2.17	<b>0.045*</b>
<b>Xiphoid (cm)</b>	5.36±1.69	5.43±1.43	0.077
<b>Subcostal (cm)</b>	4.93±2.14	4.90±2.10	0.157
<b>FEV1 (%)</b>	147.61±13.66	156.27±20.31	<b>0.002*</b>
<b>FEV1 (lt)</b>	5.94±1.19	6.23±1.58	<b>0.002*</b>
<b>FVC (lt)</b>	0.84±0.204	1.07±1.38	0.068
<b>FVC (%)</b>	144.07±13.42	150.47±20.58	0.055
<b>FEV1/FVC (%)</b>	105.51±5.58	101.23±23.86	0.523
<b>FEV1/FVC (ort)</b>	89.42±5.01	90.81±5.70	0.163
<b>PEF (%)</b>	128.86±30.38	136.31±21.03	0.266
<b>PEF (lt)</b>	9.50±2.97	10.65±2.16	0.055
<b>Shuttle run test distance (m)</b>	390.51±116.96	476.75±138.25	<b>0.001*</b>

FEV1: forced expiratory volume in one second; FVC: forced vital capacity; PEF: peak expiratory flow rate; Wilcoxon signed-rank test, \*p<0.05

Society (ATS) recommendations. The best was recorded out of the three consecutive measurements in each case. Forced expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio were recorded after the pulmonary function tests. Pulmonary function test parameters were specified as a percentage of the expected value according to age, height, weight and gender (9,10).

Chest circumference measurement (CCM) was made for the flexibility of the rib cage. CCMs were performed in the sitting position with a measuring tape, as axillar (4<sup>th</sup> rib), epigastric (xiphoid process), and subcostal (9<sup>th</sup> rib) measurements during normal and maximal inspiration and maximal expiration. Measurements were repeated 3 times and the best results were recorded in centimetres. Shuttle run test was used for aerobic performance. A cassette calibrated with signal increasing 0.5 km/h per minute was used for this test. The participants were asked to reach the end of a line of 20 m with the signal; and the test was

terminated for those who failed for two consecutive times. Heart rate, blood pressure, oxygen saturation (SaO<sub>2</sub>) and fatigue measurements were recorded before and after the test (11).

KT was applied to the diaphragm from the back and abdomen with a Kinesio Tex Tape® (Kinesio University, Albuquerque, USA). Muscle facilitation technique was applied to the diaphragmatic muscle from proximal to distal with 10–15% tension. The taping on the diaphragm from the abdomen was performed when the participant was standing and breathed-out and the body was in extension. The base of the tape was about 1 inch below the xiphoid process area. Then the arms were lifted above the head and, with maximum deep inspiration and after maximum rib cage expansion, the tails were applied with 10% tension on the rib cage. The standing patient with the arms fully extended and scapulae retracted so as to narrow the space around the 12th thoracic vertebra was asked to take a deep breath and slowly bend forward and adduct with the arms being crossed. While the patient is holding breath with maximum deep inspiration in this position, the tail of the tape was affixed to the subcostal area (5) (Figure 1). Taping was applied only once. It was not removed for 4 days.

Sham KT was performed with the same taping material. A 2-blocked I strip was applied vertically to the sternum. The same procedures were followed (Figure 2).

### Statistical Analysis

SPSS software package (SPSS 17.0) (SPSS Inc, Chicago, ABD) was used for statistical analyses. The mean±standard deviation values (X±SD) were calculated for all variables. The taping results of both groups were compared by using the Wilcoxon test. p<0.05 was considered statistically significant.

## RESULTS

A total of 36 subjects (30 females; 6 males) participated in this study. The sociodemographic parameters of the participants are shown in Table 1. All parameters were homogenous at the baseline assessment.

Pulmonary function tests showed an increase in FEV1 values four days after KT, compared to the values prior to KT (p=0.002). There was no statisti-

**Table 3.** Mean differences between KT and sham KT groups

	KT group	Sham KT group	p
Axillar (cm)	0.73±1.35	0.25±1.10	0.191
Xiphoid (cm)	0.82±1.87	0.11±1.03	0.088
Subcostal (cm)	0.88±2.32	0.63±1.85	0.493
FEV1 (%)	8.76±11.67	-0.76±36.98	<b>0.014*</b>
FEV1 (lt)	0.32±0.49	5.00±19.85	0.334
FVC (lt)	0.29±0.66	0.42±1.08	0.775
FVC (%)	6.40±12.89	13.98±28.69	0.716
FEV1/FVC (%)	79.04±26.07	75.18±25.86	0.466
FEV1/FVC (ort)	1.39±3.87	-6.29±20.50	<b>0.035*</b>
PEF (%)	7.45±26.69	-2.93±42.94	0.291
PEF (lt)	1.15±2.04	0.42±1.99	0.222
Shuttle run test distance (m)	86.24±52.24	28.56±76.17	<b>0.009*</b>

FEV1: forced expiratory volume in one second; FVC: forced vital capacity; PEF: peak expiratory flow rate; Mann-Whitney U test, \*p<0.05

cally significant difference between FEV1/FVC values ( $p>0.05$ ). There was statistically significant difference between shuttle run test results ( $p=0.001$ ) and axillar chest circumference measurements ( $p=0.045$ ) before and on the fourth day after KT (Table 2).

The mean differences between the two groups are shown in Table 3. Statistically significant difference was seen concerning FEV1 ( $p=0.014$ ), FEV1/FVC ( $p=0.035$ ) results and shuttle run test distance ( $p=0.009$ ).

## DISCUSSION AND CONCLUSION

The aim of our study was to determine the short-term effects of KT applied to the diaphragm muscle on aerobic performance and pulmonary functions of sedentary individuals. Our study shows that it improves aerobic performance and pulmonary functions in the short term and when compared to the sham KT group.

There are insufficient scientific data concerning the effectiveness and mechanism of effect of KT. Studies investigating the effects of KT on pulmonary muscles are few. Sari et al. stated that KT applied to the diaphragm and secondary pulmonary muscles had no effect on muscle strength. They also stated that their lack of spirometric measurement was a limitation (12); spirometric tests are widely used for evaluating pulmonary function. Kimothi et al. evaluated the expiratory flow rate



**Figure 1.** KT as applied to the diaphragm muscle (posterior)

before and after taping applied to the upper back, and they found that there was improvement in expiratory flow rate in the taping group, compared to the sham taping group (13). Similarly, in our study FEV1 and FEV1/FVC spirometric tests were used for evaluating pulmonary function. One week after KT, an increase was seen in FEV1 results while no change was found in FEV1/FVC results. Compared to sham KT, we found that FEV1 and FEV1/FVC results were both higher in the KT group. KT applied to the diaphragm muscle is a muscle facilitation technique stated to stimulate the mechanoreceptors of the skin that affect the diaphragm through the fascia and stimulates its fibres better (5).

Shuttle run test results, an important parameter for aerobic exercise capacity, changed after one week of KT in our study. Also compared to the sham KT group, shuttle run test results were found to be higher in the KT group. A similar study in the literature showed that KT applied to the quadriceps muscle could improve anaerobic exercise performance and athletic performance capacity. However, KT did not affect aerobic exercise capacity in this study because it

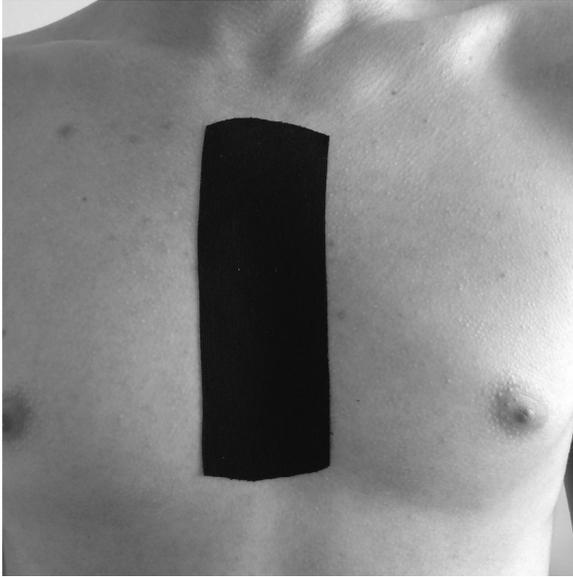


Figure 2. Sham KT

was applied only to the quadriceps muscle that did not change the aerobic exercise capacity (14).

Hernandez et al. found that KT applied to the anterior diaphragm also had no effect on exercise capacity (15). In our study, KT was applied to the diaphragm muscle both anteriorly and posteriorly, which might explain the increase found in aerobic exercise capacity; we might have affected the muscle better this way.

We did not evaluate the effects of KT on the diaphragmatic muscle strength, and this is a limitation of our study. Although there was no statistically significant difference between age and body mass index of the subjects, most participants of our study were women, which means that pulmonary functions or exercise capacity might have been affected by the menstrual cycle. It could have been more objective if the sample had been homogenized by inclusion of men only.

In concluding, KT applied to the diaphragm muscle improves aerobic performance and pulmonary functions in the short term and when compared to the sham KT group. However, further research with larger samples and longer follow-ups is needed.

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