Journal of Applied Sports Science
March 2015, Volume 5, No. 1

Acquired Kyphosis Angle in Patients with Chronic Obstructive Pulmonary Disorder with Reference to some Physiological and Physical Variables (Predictive Study).

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Abstract

The current research aims at identifying the acquired kyphosis angle in COPD patients with reference to some physiological variables (systolic blood pressure – diastolic blood pressure – FVC – FEV1) in COPD patients and some physical variables (back muscles strength – shoulder flexibility – back bone flexibility – cardio-respiratory endurance) in COPD patients, in addition to the potentiality to predict the acquired kyphosis angle in COPD patients with reference to some physical and physiological variables under investigation. The researcher used the descriptive approach. Research community included (170) male patients of stable COPD with kyphosis angle (Cobb angle) exceeding (50̊) (age = 50.37±3.42) (height = 171.99±5.65) (weight = 80.09±5.85), from the outpatient departments and respiratory diseases of Kobry Al-Qubba and Kasr Al-Ainy Hospitals. Medical exam and diagnosis is performed by a specialized physician with fully radiology scan (front/back chest x-ray – lab tests – respiratory function tests … etc.). The researcher excluded (30) patients with cardiac failure, kidney and liver diseases, diabetes, cancer, deformities other than kyphosis. Actual sample included only (140) participants (120 as a main sample and 20 as a pilot sample). The researcher used A restameter for measuring heights and medical balance for measuring weights, X-ray device, A protractor, a ruler and a pencil for measuring Cobb angle, A manometer and a stethoscope for measuring blood pressure, A spirometer for measuring respiratory function (L), A dynamometer for measuring back muscles strength (kg), A graded ruler for measuring shoulder flexibility (cm) [finger touch behind the back] and Manual counter, a stop watch, a measuring tape and an adhesive tape for measuring cardio-respiratory endurance (the step-in-place test for 2 minutes). The researcher concluded that: Kyphosis angle for participant exceeded normal range (20-45̊) as its mean value was (59.59̊) according to Cobb angle with obvious curvature of the upper back. Blood pressure of participants was high (154.50/79.79) while FVC and FEV1 were low as FVC/FEV1 ratio was 53.5%. This indicates serious respiratory deficiency. There are no statistically significant correlations between kyphosis angle and systolic BP, diastolic BP and back bone flexibility. There is a statistically significant inverse correlation between kyphosis angle and FVC and FEV1. There is a statistically significant inverse correlation between kyphosis angle and back muscles strength, shoulder flexibility and cardio-respiratory endurance. Back muscle strength can predict kyphosis angle with a contribution percentage of (29.6%). FVC and FEV1 can predict kyphosis angle with contribution percentages of (9.7%) and (5.1%) respectively. Cardio-respiratory endurance and shoulder flexibility can predict kyphosis angle with contribution percentages of (4.5%) and (4%) respectively. Systolic BP, diastolic BP and back bone flexibility cannot predict kyphosis angle .

Key words*: Acquired Kyphosis Angle – COPD – rehabilitation.*

Introduction:

Chronic Obstructive Pulmonary Disorder (COPD) is very common in the world as its occurrence increases significantly. Some speculations indicated that this disease will come third in the list of fatal diseases by the year 2020, according to WHO report. It happens due to bronchoconstriction and air flow obstruction. Therefore, it is a mix between emphysema and chronic bronchitis (35: 523-532)

Celli et al (2003), Darkow et al (2007) and Gold (2008) indicated that it is a condition of irrecoverable obstruction of air flow. Usually, the difficulty of air flow increases continually in accompany with an inflammatory response of the lungs due to inhaling irritant particles and gasses. (7: 1743) (11: 30) (14: 92).

Huard (2000) indicated that negative smoking contributes greatly in the occurrence of COPD as it increases boredom over the lung when inhaling particles and gasses. Risk increases when irritant substances accumulate as this leads to damage of airways (26: 336).

Huard (2000), Jundal et al (2006) and Halbert et al (2006) indicated that the spread percentage of COPD all over the world is about (10.1%). This percentage varies from one place to another. South Africa had the highest percentage with (22.2%) among men and (16.7%) among women, while Germany has the lowest percentage with (8.6%) among men and (3.7%) among women. (23: 338) (25: 23) (18: 532).

Jindal et al (2006), McMaster et al (2007) and Postma et al (2008) indicated that men are more vulnerable to this disease than women due to the increase of number of smokers among men. COPD normally appears after forty with slight symptoms before this age. Smoking in early age contributes greatly in early occurrence of this disease. (25: 27) (32: 203) (37: 217).

According to the American Thoracic Society and the British Thoracic Association and European society of respiratory disease, embankment to Chronic Pulmonary Obstructive chronic lung disease (copd) is a group of disorders that occur physical symptoms such as chronic cough sputum and Director changes in the sound of breathing, tightness and breathlessness, a sense of fatigue, with continued and increased disease increasingly narrow blood vessels leading to hypertension and complications in lung function and heart function due to lack of oxygen amounts, as patients muscle weakness, lack of ability to do any effort And weakness of the muscles of the exhaling is shown clearly in patients with similar habits, such as smoking and exposure to air pollution and harmful gases and vapours and allergic asthma and chest and preparedness, but the most important risk factor smoking remains the most common and the main reason for the emergence of the disease appears in individuals smoking more than 20 cigarettes a day for 20 years. (28: 23-28)

Al-Bedewy (2007), Ibrahim (2011) and Lehauck et al (2011) indicated that consequences of COPD are not limited to the lung as it affects the whole body causing general weakness, muscle weakness, osteoporosis and other negative physiological effects on various body systems. This leads to disruption of mechanical forces working on maintaining the body and making the body more vulnerable to postural deformities (2: 93) (34: 125) (29: 648).

Kyphosis is a very common deformity as the back is the axis of rip cage and arms and most muscles that move the trunk are attached to it. According to Cobb approach of radiology, hyper kyphosis is a hyper curvature of the upper back that exceeds (45°). (19: 235) (30: 20).

Daniel (2008) and Daniel et al (2009) indicated that kyphosis may be caused by several diseases that lead to sever weakness in vertebrae and bone mass. This may be due to exposure to radiation after cancer surgeries, bad or incorrect habits, gland disorders like hyper secretion of parathyroid or even arthritis (10: 354) (9: 52).

Gohs et al (2000), Harrison et al (2001) and Loder (2001) indicated that the most suitable way for measuring kyphosis is Cobb angle as it is a very common and reliable radiology measurement for kyphosis (15: 310) (19: 242) (30: 226).

There is an increased interest in COPD as it is related to general health and several studies dealt with it due to its spread and its fatality rates. This disease also increases social and economic boredom over patients to physical disability.

Gohar (2010) (16) and Al-Shazly (2013) (3) indicated that this disease is responsible for over (2.5) million deaths all over the world in 2000. In Egypt, there are over (20) thousand patients who need lung transplant and nearly (10%) of them has COPD.

Celli et al (2003) (7), Darkow et al (2007) (11) and Al-Zoghby (2011) (4) dealt with the syndromes, causes and treatment of this disease from a purely medical perspective while McMaster et al (2007) (32), Fishmanp et al (2010) (13) and Kung (2010) (28) were more interested in prevention and avoiding risks and side effects. Through review of literature and the interest in this population of patients, the research found out that acquired kyphosis is one of the side effects that COPD patients may develop. Due to the nature of this disease, back muscles become weak while the lung develops emphysema. This increases the gravity torque and the rib cage lowers down while the sternum compresses. Chest volume decreases with the decrease of space for lungs to move for normal respiration. This leads the patient to assume a posture that supports the back bone curvature, especially in the upper back. Normal curvature angle changes and reaches kyphosis. Al-Zoghby (2011) (4) indicated that (80%) of COPD patients suffer from osteoporosis. This led the researcher to perform this research to identify the acquired kyphosis angle in COPD patients, some physiological and physical variables related to this disease and the relationship between kyphosis angle and variables under investigation. In addition, the research is trying to predict the kyphosis angle with reference to research variables as prediction is of economic value due to its contribution in preventing the increase of this angle to serious rates which may increase the symptoms and side effects.

Aims:

The current research aims at:

1. Identifying:

- The acquired kyphosis angle in COPD patients
- Some physiological variables (systolic blood pressure – diastolic blood pressure – FVC – FEV1) in COPD patients
- Some physical variables (back muscles strength – shoulder flexibility – back bone flexibility – cardio-respiratory endurance) in COPD patients

2. The relationship between acquired kyphosis angle and some physical and physiological variables under investigation in COPD patients

3. The potentiality to predict the acquired kyphosis angle in COPD patients with reference to some physical and physiological variables under investigation

Research Questions:

1. What are:

- The acquired kyphosis angle in COPD patients?

- Some physiological variables (systolic blood pressure – diastolic blood pressure – FVC – FEV1) in COPD patients?

- Some physical variables (back muscles strength – shoulder flexibility – back bone flexibility – cardio-respiratory endurance) in COPD patients?

2. Is there a relationship between acquired kyphosis angle and some physical and physiological variables under investigation in COPD patients?

3. What is the potentiality to predict the acquired kyphosis angle in COPD patients with reference to some physical and physiological variables under investigation?

Methods:

<u>Approach:</u>

The researcher used the descriptive approach.

<u>Participants:</u>

Research community included (170) male patients of stable COPD with kyphosis angle (Cobb angle) exceeding (50°) (age = 50.37±3.42) (height = 171.99±5.65) (weight = 80.09±5.85), from the outpatient departments and respiratory diseases of Kobry Al-Qubba and Kasr Al-Ainy Hospitals. Medical exam and diagnosis is performed by a specialized physician with fully radiology scan (front/back chest x-ray – lab tests – respiratory function tests … etc.). The researcher excluded (30) patients with cardiac failure, kidney and liver diseases, diabetes, cancer, deformities other than kyphosis. Actual sample included only (140) participants.

Table (1)
classification of participants

Community	Excluded	Pilot sample	Main sample
170	30	20	120

<u>Data Collection Tools:</u>

Interviews:

The researcher interviewed respiratory diseases physicians and sports injuries and rehabilitation specialists to identify their opinions about the research rationale, suitable sample and physiological and physical variables. The researcher thinks that (80%) of experts' agreement is satisfying. Each patient was interviewed to explain procedures and to get the personal signed consent for participating in this research.

Equipment:

- A restameter for measuring heights and medical balance for measuring weights
- X-ray device (26: 186)
- A protractor, a ruler and a pencil for measuring Cobb angle
- A manometer and a stethoscope for measuring blood pressure
- A spirometer for measuring respiratory function (L)
- A dynamometer for measuring back muscles strength (kg)
- A graded ruler for measuring shoulder flexibility (cm) [finger touch behind the back]
- Manual counter, a stop watch, a measuring tape and an adhesive tape for measuring cardio-respiratory endurance (the step-in-place test for 2 minutes) (21) (38) (6) (8) (27)

• Measuring conditions and test order were all unified for main measurements and validity and reliability measurements.

• A detailed explanation of the devices and tests used annexes (2)

<u>Application:</u>

Each patient was individually examined and his scores over research measurements were recorded in a specific data log. Research measurements were applied from 25-7-2013 to 30-12-2013 according to the following order: x-ray – Cobb angle – respiratory function – physical tests.

<u>Statistical treatment:</u>

The researcher used SPSS software to calculate the following: mean – SD – squewness – Person's correlation coefficient – (t) test. Simple linear regression was calculated according to the following equation: y = a + b1x1 (where a is a constant, b1 is the independent variable, y is the dependent variable and x1 is the correlation coefficient.

Results and Discussion:

First: Results concerning Cobb angle, physiological variables (systolic BP – diastolic BP – FVC – FEV1), physical variables (back muscles strength – back bone flexibility – shoulder flexibility – cardio-respiratory endurance) and the relationship between Cobb angle and physical and physiological variables:

Table (2)

mean, SD and Squewness for research variables (n=120)

Variables		Mean	SD	Squewness
Kyphosis angle	Cobb angle	59.59	3.96	-0.301
physiological variables	systolic BP	154.5	6.46	-1.33
	diastolic BP	79.79	5.62	-0.205
	FVC	2067.70	251.09	-1.92
	FEV1	1107.42	45.19	0.145
	FVC/ FEV1 ratio	1107.42/2067.70	53.5%	--
physical variables	back muscles strength	45.45	5.86	-0.388
	back bone flexibility	4.35	0.768	0.233
	shoulder flexibility	-4.51	1.00	0.151
	cardio-respiratory endurance	31.67	2.59	1.26

Table (2) shows mean, SD and squewness of all research variables.

Table (3)

Correlation Coeffecients between Cobb angle and each physiological and physical variable (n=120)

Physiological variables	r	Significance	Physical variables	r	Significance
systolic BP	-0.534	0.524	back muscles strength	*-0.268	0.003
diastolic BP	-0.025	0.790	back bone flexibility	0.176	0.054
FVC	*-0.260	0.004	shoulder flexibility	*-0.296	0.001
FEV1	*-0.254	0.009	cardio-respiratory endurance	*-0.199	0.029

*$P \leq 0.05$

Table (2) indicates the values of Cobb angle, systolic BP, diastolic BP, FVC, FEV1, back muscle strength, shoulder flexibility, back bone flexibility and cardio-respiratory endurance for COPD patients.

Table (3) indicates a passive statistically significant correlation between Cobb angle and physiological variable (FVC – FEV1) while there is no correlation between Cobb angle and systolic BP and diastolic BP. In addition, there is a passive statistically significant correlation between Cobb angle and physical variable (back muscles strength – shoulder flexibility – cardio-respiratory endurance).

First, participants underwent a lateral chest x-ray with both arms over shoulder and a holding a deep breath for a few seconds during being exposed to x-ray. Through Cobb angle, kyphosis angle was determined. This is a common method in determining kyphosis through radiology.

Harrison et al (2001) (19) and Willner (2010) (41) indicated that when kyphosis is evaluated by Cobb angle from T3 to T12, it is considered normal if it ranged between 20° to 45°. Cobb angle indicated that kyphosis angle in those patients was 59.59°. This is considered abnormal due to the increase of symptoms like quick exhaustion and pain, especially at the peak of leaning with induration of vertebrae. These symptoms were indicated by Daniel et al (2009) (9) and Lehouck et al (2011) (29).

Lehouck et al (2011) (29) indicated that COPD is closely related to osteoporosis as there are numerous common risk factors between them like age, smoking and respiratory dysfunction. These lead to bone weakness and in turn to increased kyphosis.

Table (2) indicated that mean systolic BPwas 154.5 while mean diastolic BP was 79.79. This clearly shows an increased value of blood pressure, especially arterial blood pressure. This is consistent with Al-Bedewy (2007) (2) and Mohamed (2011) (34) who indicated that COPD patients suffer from cardiac difficulties, especially at the right part of the heart as it should pump blood strongly through tight pulmonary blood vessels. This increases arterial blood pressure with a clear deficiency of the heart's right part.

This is also consistent with Augusti (2005) (1), McMaster et al (2007) (32) and Postme et al (2008) (37) who indicated the COPD patients suffer from high arterial blood pressure due to insufficiency of oxygen and the damage of pulmonary vesicles.

Table (3) indicated no statistically significant correlations between kyphosis angle and systolic or diastolic blood pressure as high blood pressure was significantly correlated to COPD due to respiratory deficiency.

This is consistent with Swanney et al (2008) (40) and Lehouck et al (2011) (29) who indicated that kyphosis does not directly affect blood pressure. Instead, it affects the respiratory system negatively which in turn affects the efficiency of the heart and blood vessels negatively.

Table (2) indicated that Fast Vital Capacity (FVC) was 2067.70 while exhale volume at the first second (FEV1) was 1107.42 and the ratio between them was 53.5%. It is noticeable that the volume of exhale air out of the lungs is lower than normal at the same age group. It is also noticeable that exhale volume after the first second of full inhale is significantly lower than FVC. FEV1/FVC ratio was far below normal range of reference. This indicates deficiency in air flow.

This is consistent with Swanney et al (2008) (40), Hyatt et al (2010 (24), Morris Mand Mohy (2010) (36), Gohar (2010) (16) and Mohamed G. S. (2011) (35) who indicated that FVC and FEV1 decrease significantly in COPD patients due to emphysema and air obstruction in addition to weakness of respiratory muscles and breathing difficulty. Guyton (2006) (17), Modry Kamien et al (2009) (33) and Barnest (2011) (5) indicated that COPD is a group of respiratory diseases and evaluating FVC and FEV1 are used as they are very significant in diagnosing respiratory function and mechanical aspects of the lungs.

Stanojevic et al (2008) (39) indicated that if FEV1 is less than FVC, this indicated and obstruction or airways.

Swanney et al (2008) (40) FVC/FEV1 ratio is called Tiffeneau index. It is calculated and used in diagnosing lung diseases. Its normal value is nearly 80%. This value was 53.5% for this research sample while the same value for healthy adults is 75-80%. This decrease is due to the resistance of airways to exhale air flow. Tis resistance decreases FEV1 and FVC which in turn decreases the ratio below 80%. This is completely consistent with Stanojevic et al (2008) (39).

Table (3) indicated a statistically significant invers correlation between kyphosis angle and FVC and FEV1. With the increase of kyphosis angle, respiratory functions decrease. Results of this research indicated that this angle reached 59.59° (very high value compared to normal 45°) while respiratory measurements decreased significantly.

This is consistent with Lombardil et al (2005) (31), McMaster et al (2007) (32), Willners (2010) (41) and Lehouck et al (2011) (29) who indicated that the increase of kyphosis angle results from lung dysfunction and emphysema. This forces the patient to assume a posture that leads to back bone curvature, especially at the upper back. This changes the angle gradually until it reaches kyphosis.

Table (2) indicated that means of back muscles strength, back bone flexibility, shoulder flexibility and cardiorespiratory endurance were 45.45kg, 4.35 cm, 4.51 cm and 31.67 counts respectively. Table (3) indicates a statistically significant invers correlation between kyphosis angle and back muscles strength, shoulder flexibility and cardiorespiratory endurance while there is no correlation between kyphosis angle and back bone flexibility. The researcher thinks that this is due to the elongation and weakness of back muscles and ligaments with the shortness and contraction of chest muscles and ligaments as this increases curvature angle. One of the most common side effects of COPD is the gradual weakness of muscles and loses of bone and lung tissue mass. This increases deformities of the body. Shoulder joint is the nearest joint to the upper back and due to the anatomical changes of this area, in addition to respiratory deficiency, the flexibility of this joint decreases and leads to decreasing the efficiency of the cardio-respiratory system.

Hassanain et al (2003) (20), Lombardil et al (2005) (31), Daniel (2008) (10), Daniel et al (2009) (9), Willners (2010) (41) and Al-Shazly (2013) (3) indicated that postural deformity in general, and especially kyphosis, affects negatively the respiratory function and physical abilities. The weakness of the muscle mass decreases the muscle function due to the disturbed protein anabolic/metabolic function balance. This disturbs energy balance and causes complex metabolic disorders that lead to osteoporosis and muscle weakness. This increases the occurrence of kyphosis.

This fulfills the first and second aims and answers the first and second questions.

Second: Results and Discussion concerning prediction of kyphosis angle with reference of physiological and physical variables.

Table (4)

Prediction Equations Linear Regression of Kyphosis Angle for Participants

Step	Constant	Standard error	Contributors						Contribution percentage
			F	Strength	FVC	FEV1	Endurance	Flexibility	
1-	54.30	1.60	11.37	-1.17	-	-	-	-	29.6%
2-	26.23	9.38	10.67	-1.16	0.024	-	-	-	39.3%
3-	35.90	9.96	9.51	-1.07	0.021	-0.142	-	-	44.4%
4-	32.40	9.85	9.01	-1.06	0.025	-0.159	1.05	-	48.9%
5-	30.16	9.06	8.15	-1.04	0.023	-1.73	1.26	-2.04	52.9%

Table (4) shows variables contributing in Cobb angle for this research's participants as follows:

- First contributor **(back muscle strength)** with a percentage of (29.6%) and by applying the following equation: y = a + b1x1, Cobb angle = 54.3 – (1.17 x correlation value).
- Second contributor **(FVC)** with a percentage of (9.7%) as it increased contribution percentage from (29.3%) to (39.3%) and by applying the following equation: y = a + b1x1 + b2x2, Cobb angle = 26.23 – (1.16 x correlation value) + (0.024 x correlation value).
- Third contributor **(FEV1)** with a percentage of (5.1%) as it increased contribution percentage from (39.3%) to (44.4%) and by applying the following equation: y = a + b1x1 + b2x2 + b3x3, Cobb angle = 35.90 – (1.07x correlation value) + (0.021 x correlation value) + (0.142 x correlation value).
- Fourth contributor **(cardio-respiratory endurance**) with a percentage of (4.5%) as it increased contribution percentage from (44.4%) to (48.9%) and by applying the following equation: y = a + b1x1 + b2x2 + b3x3 + b4x4, Cobb angle = 32.40 – (1.06 x correlation value) + (0.025 x correlation value) + (1.59 x correlation value) + (1.05 x correlation value).
- Fifth contributor **(shoulder flexibility)** with a percentage of (4%) as it increased contribution percentage from (48.9%) to (52.9%) and by applying the following equation: y = a + b1x1 + b2x2 + b3x3 + b4x4 + b5x5, Cobb angle = 30.16 – (1.04 x correlation value) + (0.023 x correlation value) + (1.73 x correlation value) + (1.26 x correlation value) + (2.04 x correlation value).

Through data analysis, table (4) indicates that contribution percentage of back muscle strength in predicting kyphosis angle in COPD patients was (29.6%) while the percentages of contribution of cardio-respiratory endurance and shoulder flexibility were (4.5%) and (4%) respectively. Back bone flexibility did not contribute in predicting kyphosis angle. These results indicate that back muscle strength and shoulder flexibility can be used to detect any weakness in this area and to early diagnose kyphosis, in addition to initiating preventive exercises to prevent kyphosis from being worse.

Contributions of FVC and FEV1 in predicting kyphosis angle were 9.7% and 5.1% respectively. These percentages were less than the percentages of physical variables but they necessitate immediate intervention to prevent disease from being worse. Systolic and diastolic blood pressure did not contribute in predicting kyphosis angle but they are indirectly related to back bone muscles and bones.

Dennis & Mark (2000) (12) and Hirayama (2009) (22) indicated that COPD should be dealt with immediately after diagnosis to decrease symptoms and prevent disease from being worse in addition to enhancing the physical, motor and respiratory conditions of the patient. Kung et al (2010) (28) indicated that the best plan to deal with COPD is through evaluating and monitoring patients and decreasing risk factors to prevent side effects of the disease.

This is consistent with Lombardil et al (2005) (31) and McMaster et al (2007) (32) who indicated that increased kyphosis angle is related to weak breathing, pulmonary ventilation dysfunction, muscle and joint weakness and osteoporosis. This is also consistent with Lehouck et al (2011) (29) who indicated that pulmonary damage increases kyphosis. Kung et al (2010) (28) indicated that respiratory assays and muscle strength and bone density measurements have very positive uses in predicting the health conditions.

This fulfills the third aim and answers the third question.

Conclusions:

1. Kyphosis angle for participant exceeded normal range (20-45 ̊) as its mean value was (59.59 ̊) according to Cobb angle with obvious curvature of the upper back
2. Blood pressure of participants was high (154.50/79.79) while FVC and FEV1 were low as FVC/FEV1 ratio was 53.5%. This indicates serious respiratory deficiency. There are no statistically significant correlations between kyphosis angle and systolic BP, diastolic BP and back bone flexibility.
3. There is a statistically significant inverse correlation between kyphosis angle and FVC and FEV1.
4. There is a statistically significant inverse correlation between kyphosis angle and back muscles strength, shoulder flexibility and cardio-respiratory endurance.
5. Back muscle strength can predict kyphosis angle with a contribution percentage of (29.6%).
6. FVC and FEV1 can predict kyphosis angle with contribution percentages of (9.7%) and (5.1%) respectively.
7. Cardio-respiratory endurance and shoulder flexibility can predict kyphosis angle with contribution percentages of (4.5%) and (4%) respectively.
8. Systolic BP, diastolic BP and back bone flexibility cannot predict kyphosis angle.

Recommendations:

1. Kyphosis should be diagnosed at the initial evaluation of COPD patients to identify excessive kyphosis
2. Excessive kyphosis should be treated to improve respiratory function for improving quality of life and decreasing social boredom of COPD patients.
3. Performing more research to identify common posture deformities and its effects on respiratory function of COPD patients.
4. Designing health and posture guidelines and programs for motor rehabilitation exercises primarily for prevention in case of the absence of excessive kyphosis and then for treating kyphosis per ce to minimize its risk factors on those patients as shown in annex (2)

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