

## Review Article

### Effect of swiss ball exercises on some physical and physiological variables and their relationship with kata performance level.

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#### Abstract

The present work aims to study the effect of Swiss ball exercises on the abdominal, back and leg muscles strength, hip and spine flexibility, static and dynamic balance and Vital Capacity in addition to their relationship of Gankaku Kata performance level. (12) Women Karateka aged (18-20) years from Zagazig University karate first- team participated in 8 weeks Swiss Ball exercises. The present study included Sit- Up legs- straight, Back Lift Strength, leg lift strength, grand car flexibility, Trunk Extension Flexibility, stroke Stand, Modified Bass Test of Dynamic Balance and Vital Capacity Tests, surface electromyography (EMG) was used to assess abdominal and back muscles activity during kata skills, The level of performance was evaluated by five Judges accredited by the Egyptian Federation of Karate. Results showed significant differences between the two measures of physical and physiological variables with improvement of Gankaku Kata performance.

**Key Words:** Balance – strength – Flexibility – EMG –Vital capacity – Gankaku kata

#### Introduction

Karate is one of the most popular martial arts practiced both inside and outside of Japan. Traditional karate training involves basics, kata and sparring. Basic techniques such as punching, kicking, blocking and striking are practiced either in a stationary position or with body movements in various formal stances, sparring is the execution of defensive and offensive techniques while freely moving against an opponent (Nakazawa et al. 1998).

Kata is a performance of series according to a system recognized by the international styles of defense and attack as blocking, punching and kicking in different trends and speeds directed to the three levels of the body of the attacker or group of phantom attackers through many different balance positions (Ebrahim, 1995).

From the traditional principles of assessing the performance of a contestant or team, the judges are looking for the balance and focus of power correctly and the proper use of breathing as an aid to kime and proper tension in the abdomen (HARA) with no bobbing up and down of the hips during movements (WKF,2009).

Gankaku kata is the kata formerly called chintō it takes its present name "crane on a rock" from the postures that just like a crane standing on one leg on a rock. It is appropriate for mastering balance while standing on one leg and simultaneously counter attacking with the side kick and back fist; it includes forty – two movements in about one minute (Nakayama, 1981). It is very important to concentrate on strength and balance in performance to overcome the opponent when the one stands on one leg for counter attacking by Yoko Jerry Uraken (Al Said, 2001). The kicks require standing on one leg and the other kicking leg is to be raised from the ground and take the form of circle in the air which requires from the karateka to overcome the torque output of the inertia and resist in the opposite direction of movement and also during the performance of kata, the karateka moves from skill to another and this requires changing the status of the weight of the body position to another one and this change in the center of gravity needs to balance (kmal, 2004).

Abdominal muscles strength and balance represent the basic needs of Gankaku kata performance. The trunk muscles (abdominal and back muscles) are important in many sport activities where it is the main center of movement distribution during performance that contributes of achieving the stability of trunk and subsequently the whole body (Abd maksoud , 1997; Dean & Greg 1997).

Swiss Ball Exercises is one of rubber resistors trainings, it leads to increase the resistance of whole working muscles and therefore increase and improve the power of abdominal and back muscles. For this reason it is used as session of physical fitness developing exercises (Jenny, 2006; Better, 2004), it can be used to evaluate and train balance and co-ordination (Beate , 2005)

The present work aims to study the effect of Swiss ball exercises on the strength of abdominal, back and leg muscles, flexibility of hip and spine, static and dynamic balance and vital capacity in addition to their relationship with Gankaku Kata performance level.

## Materials and methods

### Subjects

Twelve women karateka were selected for the present study from Zagazig University Karate first team to apply Swiss ball exercises, In addition to one woman karateka in the Egyptian karate team was conducted for measuring EMG as ideal model in kata performance. This study was carefully explained and informed consent was given by all karateka. Table shows the mean  $\pm$  SD for Age (years) for height (cm), for body Weight (kg) and Training Age (years) with there Skew co-efficient (homogeneity of study sample).

**Table 1 Homogeneity of study sample**

variables	Mean $\pm$ SD	Skew co-efficient
Age (years)	19.08 $\pm$ 0.79	0.30
Height (cm)	163.92 $\pm$ 3.0	0.07
Weight (kg)	64.67 $\pm$ 2.81	0.89
Training Age(years)	6.75 $\pm$ 0.62	1.21

### Study design

This study used experimental method by using pre - post measurement of one experimental group.

### Methods:

#### Experimental design

##### - in the beginning in the work:

The details of Swiss ball exercises and the study variables was accepted by physiological and karate training specialists.

##### • Gankaku kata analysis

Technical analysis of the Kata was done to know the movements of Kata, about 42 movements in 60 seconds to determine the conditions of balance, then anatomical analysis of the kinetic methods (attack and defense of Kata) to determine the most important movements requires during kata attack and defense with the conditions of balance and its importance in the overall assessment of the Kata performance, which shows the clear constriction of the abdominal and back muscles also it was performed more than one time during performing movements of Kata.

The selected skills of kata fourth movements ( Migi Ken Chudan Gyaku Zuki ), Twelfth movements ( Ryo Sho Chudan Kakiwake Uke) and full movements (29 – 32) are selected (Hidari Sokumen Jodan Uke Kamae, Migi Sokumen Gedan Kamae – Ryo Ken Hidari Koshi Kamae – Migi Uraken Jodan Yoko Mawashi Uchi, Migi Sokuto Chudan Yoko Keage – Hidari Ken Migi Sokumen Chudan Zuki, Migi Ken Migi Koshi )

Muscles of abdomen and back are determined: Right and left of External abdominal M., Rectus abdominal M., Erector spine M. and Internal abdominal oblique M. by recording the electromyogram during the performance of Kata skills.

##### • Determination of Muscle Activity

To determine muscle activity, the EMG was used. EMG was recorded by 2 electrodes and a ground electrode placed above the active muscle the relationship between tension in muscle and surface EMG amplitude is linear. Thus, the amplitude of the surface EMG can be used effectively as a measure of activity of the underlying muscle by simply normalizing the EMG in terms of a maximal effort.

Muscle activity was therefore assessed by first measuring (Jerrold et al., 2007) diagramming the electrical activity on the abdominal and back muscles specific to the left and right using EMG before the application during the performance of a women karateka from Egypt which chosen from the analysis of Kata movements before applying the study to determine the percentage sharing of abdominal and back muscles during performing this skills as a training determiner.

EMG measurement was done in one women karateka in the Egyptian karate team.

**The following figures show EMG of the abdominal and back muscles during the selected movements and the percentage sharing of each muscle during Gankaku kata performance.**

<p>Figure (1) Shows the abdominal and back muscles during Migi Ken Chudan Gyaku Zuki that the left Erector spine M. represent the higher sharing (18 %) obtained the present study, then the left External abdominal oblique M. (17%), then the right Internal abdominal (16%), then the right External abdominal oblique M. (14%), then the left Rectus abdominis M. (12%), then the left Internal abdominis M. (9 %), then the right Erector spine M. (9 %), then the right Rectus abdominis M. (3%)</p>	<p>Figure(1)</p>
<p>Figure (2) Shows the abdominal and back muscles during that Ryo Sho Chudan Kakiwake Uke that The left Internal abdominis M. represent the higher sharing (20%) obtained the present study, then the left External abdominal oblique M. (19%), then The right External abdominal oblique M. (15%), then the right Erector spine M. (12%), then the left Erector spine M. (11%), then the right Internal abdominis M. (11%), then the left Rectus abdominis M. (10%), then the right Rectus abdominis M. (3%).</p>	<p>Figure(2)</p>
<p>Figure (3) Shows the abdominal and back muscles during Hidari Sokumen Jordan Uke Kmae, Migi Sokumen Gedan Kamae – Ryo Ken Hidari Koshi Kamae – Migi Uraken Jordan Yoko Mawashi Uchi, Migi Sokuto Chudan Yoko Keage – Hidari Ken Migi Sokumen Chudan Zuki, Migi Ken Migi Koshi that the left Rectus abdominis M. represent the higher sharing (18 %) obtained the present study , then the left Erector spine M. (16%), then the right Internal abdominis M. (15%), the right Erector spine M. (13%), then the left External abdominal oblique M. (12%), then The right External abdominal oblique M. (11%), and the left internal abdominis M. (11%), then the right Rectus abdominis M. (4 %).</p>	<p>Figure(3)</p>

• **Recording physical tests, vital capacity and Gankaku kata Performance level were done just pre and post Swiss ball exercises as follows :**

• **Physical Tests**

- Sit- Up legs- straight test is used for measure abdominal muscles strength,
- Back lift strength test used for measure the strength of back by dynamometer,
- Leg lift strength test used for measure the strength of legs by dynamometer,
- Grand car test used for measure the hip flexibility,
- Trunk extension test used for measure the spine flexibility,
- Stroke stand test used for measure static balance,
- Modified bass test used for measure dynamic balance (Radwan& Allawi, 2001; Musaad, 1999; Hassanen, 1999) .

• **Physiological Test**

- Vital capacity was measured by spirometer (ml) ( saad , 2002).
- **Gankaku kata Performance level**

The level of performance was evaluated by five judges accredited by Egyptian Federation of Karate; every judge puts a point from 10 points then excluded the highest point and minimum point and the sum of the other three points of the three judges are calculated.

- **Swiss Ball Exercises**

The selected women karateka were subjected to Swiss ball exercises for 8 weeks (4units weekly), Swiss ball is a rubber ball full of high air pressure, and has many colors and sizes its diameter between 55cm to 95 cm to suit all the size of every body who exercise by it. Before use an Exercise ball, make sure that the right size for each player height and test it by sitting on the ball and make sure that the hips of each player at the level or just slightly higher than the knees (Adam, 2005; Joniraffoul, 2005).

The daily exercises start with the session of warm up and general physical preparation during 15 minutes in the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> week, 10 minutes during 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup> week, reaches 5 minutes in 7<sup>th</sup> and 8<sup>th</sup> week, include general exercises for the body and to be difficult gradually take into account the exercises help all the body and performed between 55%-75% from the maximum of repetitions the right performance. The session of special physical preparation per unit contains a group of exercises using a Swiss Ball to develop the muscles strength of the abdomen, leg, back and flexibility of the trunk and spine and static and dynamic balance. Five exercises performed in the daily unit, include Swiss ball exercises and fixed rate of four units weekly, Time of the one exercise 30seconds with resting interval of 30 seconds between two exercises i.e. the whole unit takes 270 seconds and takes rest 135 seconds between exercises groups. The intensity of exercise between 80 – 95 % from the maximum of repeating the right performance with stable time of each exercise , the exercises ranging in its difficulty, the first five exercises performed in the 1<sup>st</sup>, 3<sup>rd</sup>, 5<sup>th</sup>, and 7<sup>th</sup> weeks, and the second five exercises performed in 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup>, one group performed during 1<sup>st</sup> and 2<sup>nd</sup> week, two groups in 3<sup>rd</sup> and 4<sup>th</sup> week, three groups in 5<sup>th</sup> and 6<sup>th</sup> week, four groups in 7<sup>th</sup> and 8<sup>th</sup> week , the time of Swiss ball exercises in the first unit 6.75min , it reaches 27 min in the last unit , The main session which contains special exercises like performed skills and exercises on performed skills and movement of Gankaku Kata with intensity 75-95 % from the actual time of Gankaku Kata. The final session cooling down includes breathing exercises will slow down the heart rate and calm the mind and stretching exercises will help prevent muscles stiffening perform about 10minites(Sean,2008).

### Statistical analysis

Data were examined using a computerized statistical package (SPSS). Differences between measuring group were analyzed using paired samples T-Test. And Correlation between variables was assessed by a Pearson's correlation coefficients. Significance was accepted at the  $p < 0.05$  level.

### Results

**Table 2 Differences of physical variables between pre- post measurements.**

N=12

	Variables	Pre	Post	T
		M± SD	M± SD	
Strength	Abdominal M.(number)	16.5 ± 1.62	28.50 ±2.15	19.50*
	Back M. (kg)	62.25 ±5.86	74.92 ± 8.92	5.41*
	Legs M.(kg)	65±4.31	76.92 ± 3.5	7.75*
Flexibility	Hip M. (cm)	40.58± 3.58	30.92± 4.44	10.65*
	Spine M.(cm)	18.33± 1.78	24.17 ±1.85	6.58*
Balance	Static (min)	1.19 ±0.21	1.98±1.56	12.23*
	Dynamic (degree)	24±2.26	30 ±1.95	6.63*

Value of (T) at the level of 0.05 = 2.201.

\*Significantly different between pre - post training.

Figure (4) shows improvement percentage (%) for physical variables between pre- post measurements

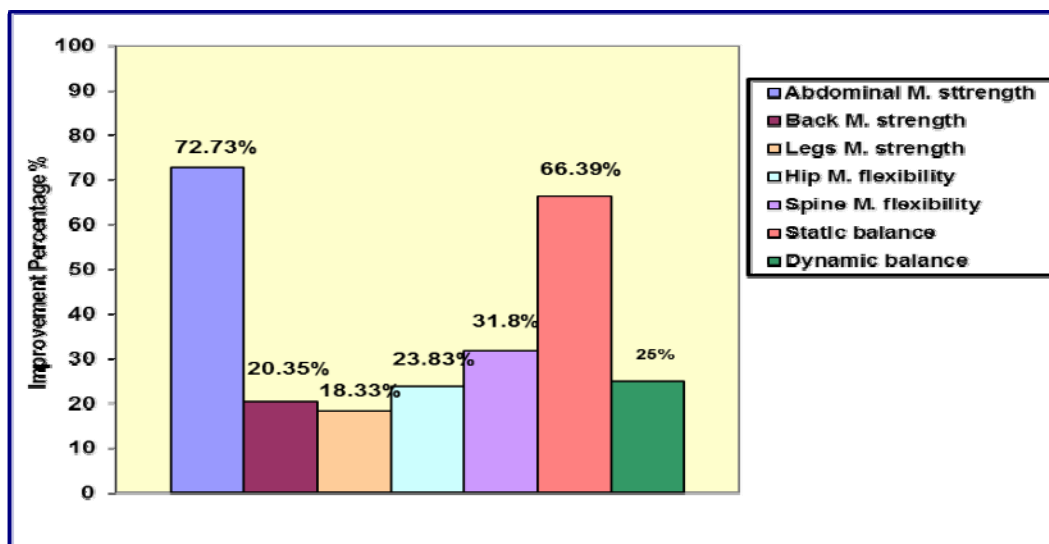


Figure (4)

Table 3 Differences of variables physiological between pre- post measurements. N=12

Variables	Pre Mean± SD	Post Mean± SD	T	Improvement Percentage%
Vital Capacity (ml)	3679.58 ±412.81	4120±204.94	4.20*	11.96

Value of (T) at the level of 0.05 = 2.201  
\*Significantly different between pre- post training.

Table 4 Differences of Gankaku kata performance level between pre- post measurement. N= 12

Variables	Pre M± SD	Post M± SD	T	Improvement Percentage%
Gankaku Kata performance level (Degree)	15.66±0.17	16.65± 0.24	17.18*	6.32

Value of (T) at the level of 0.05 = 2.201  
\*Significantly different between pre- post training.

Table 5 Correlation coefficients results between Gankaku kata performance level and physical, physiological variables. N= 12

Variables		R
physical	Abdominal M. strength× kata	.597*
	Back M. strength× kata	.262
	Legs M. strength× kata	.166
	Hip M. Flexibility× kata	.136
	Spine M. Flexibility× kata	.029
	Static Balance× kata	.656*
	Dynamic Balance× kata	.156
Physiological	Vital Capacity × kata	.653*
	Vital Capacity × Abdominal M. strength	.639*

Correlation is significant at the level 0.05 = 0.576

Figure 5 shows correlation coefficients results between Gankaku kata performance level and abdominal M. strength

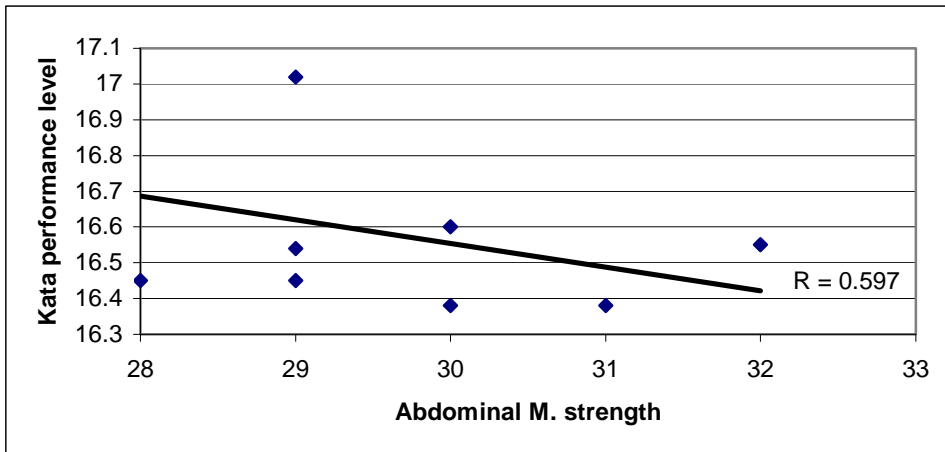


Figure (5)

Figure 6 shows correlation coefficients results between Gankaku kata performance level and static balance

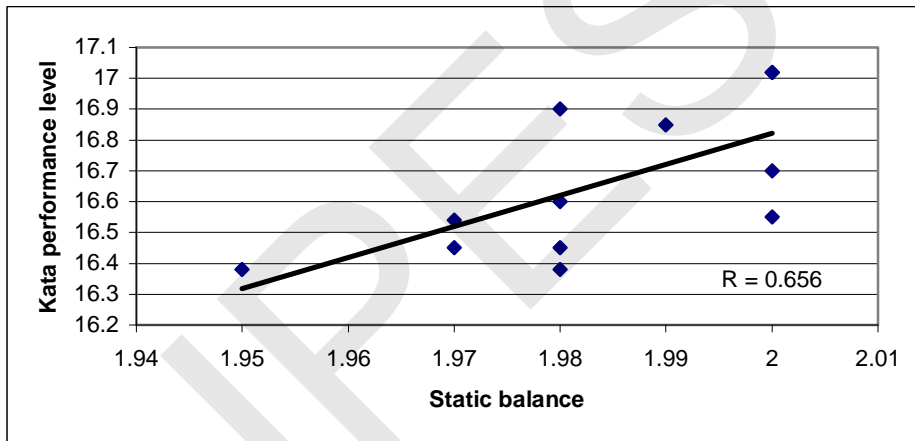


Figure (6)

Figure 7 shows correlation coefficients results between Gankaku kata performance level and vital capacity

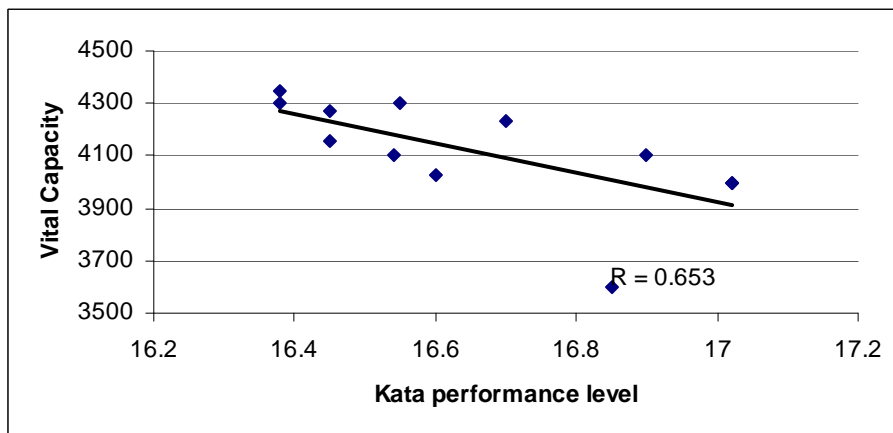
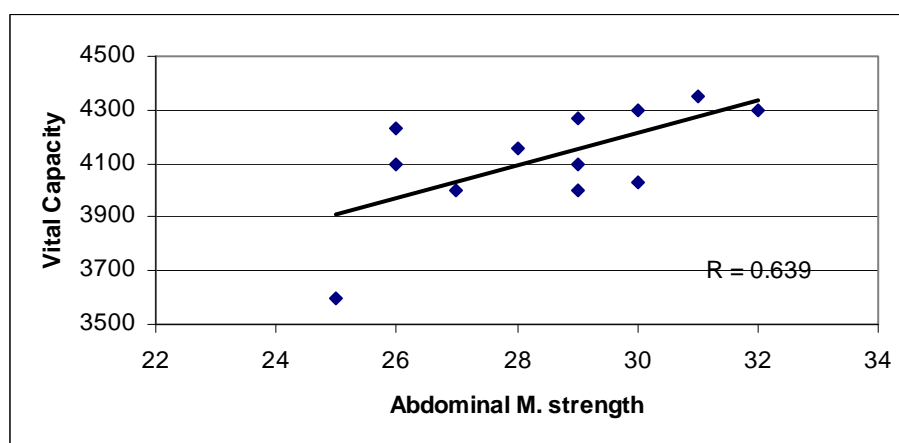


Figure (7)

**Figure (8) shows correlation coefficients results between Abdominal M. strength and vital capacity****Figure (8)**

## Discussion

Table (2) shows significant increase in the post measurements in all physical variables with highest improvement rate of abdominal M. strength ( 72.73% ), then Static Balance (66.39% ), then Spin M. Flexibility( 31.80%), then Dynamic balance ( 25 % ), then Hip M. Flexibility( 23.83%), then Back M. Strength (20.35%), then legs M. Strength (18.33 %). The researcher attributed these results to the effect of Swiss ball exercises that contributed to improve the strength of abdominal and back muscles (trunk muscles) as the main center of movement distribution during performance that led to the highest rate of maintaining the stability of trunk and subsequently the whole body balance. Marshall and Murphy (2005) claimed that Swiss ball exercises provides a training stimulus for the rectus abdominal muscles and "Jerrold et al. ( 2007 ) agree as well that Swiss ball exercises lead to increase the core muscles sharing to stabilize body balance

The results of this study was matched with studies of (Gregory, 2005; Paul et al., 2005; Lehman et al., 2005; Mori, 2004; cosio et al., 2003) which showed that Swiss ball exercises positively affect the strength of abdominal, back and legs muscles , Flexibility of trunk muscles and balance.

Table (3) shows significant increase in the post measurement of vital capacity (11.96%)

The researcher believes that the improvement in vital capacity in this study may be due to an increase in abdominal muscles strength which leads to an improvement in the strength of respiratory muscles. This corresponds with the view of (Taha et al. 2002) which states that the improvement in the strength of respiratory muscles contraction (the diaphragm, the external intercostal muscles, the levator scapulae, the scalene muscles, the serratus anterior, internal intercostal muscles and abdominal muscles) provide improvement in the vital capacity This explanation is in harmony with that of (Berger, 1982) who postulated that the improvement of respiratory muscles performance may play a significant role in the optimization of pulmonary functions of athletic subjects. Taha et al. (2002) stated that regular exercise usually results in an increase of vital capacity especially in children, adolescents, and young adults.

Table (4) shows significant increase in the post measurement of Gankaku Kata performance level (6.32%)

The researcher returns these results to the positive effect of Swiss ball exercises on the strength of abdominal, back and legs muscles, flexibility of spine and hip, static and dynamic balance and vital capacity. these variables may contribute to improve the performance of Kata This is correct with the results of Studies of ( Ebrahim , 2009; Plamondon et al., 1999) which proved the importance of training to strength back and abdominal muscles that may lead to develop and improve activity of these muscles , therefore increasing Gankaku kata level performance.

Strengthening abdominal muscles are of vital importance when performing punch to the opponent, and require a delicate balance of karateka (Maffulli et al., 2009).

Table (5) shows significant relationship between Gankaku Kata performance level with the strength of abdominal muscles, static balance and vital capacity and also there are significant relationship between abdominal muscles strength and vital capacity.

The researcher returns that improvement was due to the effect of Swiss ball exercises on the strength of abdominal and back muscles (trunk muscles) which in turn lead to a better balance essential for basic karateka when performing some of the skills that require standing on one foot during the performance of Gankaku Kata and this compatible with ( Kamal, 2004; Ebrahim, 1995; Nashayama, 1982 ; Arnil & Diwler, 1979 ) who are stated that Karate is characterized by diversity of main skills ( single - complex) in changing attitudes that require the karateka should be more balanced during attack and defense processes ,Some complex skills



specially kicks need balance because the two legs exchange on air simultaneously when performing the kicks and this needs high balance by karateka when doing this complex skills .

The study results of ( Hessen , 2007) also stress on the positive effect of Swiss ball exercises on the strength of abdominal and back muscles and balance to improve the performance for combat sports.

Swiss ball exercises also led to improve vital capacity which have a positive effect on breathing to be used as an adjunct to the Kime (turning and stopping hip) In other words, Swiss ball exercises contribute to the development of the working muscles of the hip joint which is the focus of control performance-oriented styles skill components of the structure built for total mobility "kata" and this indication in both the( Okazaki and Stricevic, 2007: Abu Fotouh ,2010 )The effect of control in the movement of the pelvic area is considered one of the most important criteria for the International Assessment of the performance components of the structure built for total mobility "kata" in addition to the vital capacity is one of the requirements, contributing to the overall performance of the structure built for total mobility, which is reflected in assessing its level of performance where follow the process of inhalation and exhalation through performance rated is working on an adaptation of the function of the muscles of the chest and upper abdomen, , so we find that the emergence of correlation between vital capacity and between kime as well as the strength of the abdominal muscles which is the center of stabilizing contraction installed to the hip joint during the performance techniques is a positive indicator can be directed to operations selection and training of the specialty kata. Sean (2008) and Ebrahim ( 2002) confirmed that kata performance include fast and slow movements, tension and relaxation of the abdominal muscles with an deep breathing in the abdomen and control is one of basic requirements contributing in kata training field, whether performance follows the style shoria or shoran which are two styles that fall under them all the International Karate schools, which consider that the exchange between tension and relaxation for all the body and especially the abdomen and pelvis area as a guide to performance skill of the karateka.

The opinion of the researcher that Proper breathing is one of the most important points in performance kata . Breathing should change with changing situations but basically inhale when blocking, exhale when a technique is executed. Also breathing is correlated with the Kiai that occur in several times during the performance of the structure built for inter kinetic "kata" and the number of times depends on the philosophy of performance through the school that belong kinetic "kata", and its performance range between 2-4 repetitions and the Kiai is performed at the exhaling moment which when performed very sharply with tensing the abdominal muscles, extra power can be given to the muscles (Nakayama, 1979)

#### Conclusion:

- The percentage participation of the abdominal and back muscles sharing in the most skills of Gankaku kata performance where have been identified.
- Swiss ball affect a positive impact on the strength of abdominal, back and legs muscles, flexibility of spine and hip and static, dynamic balance.
- Swiss ball affect a positive influence on vital capacity which have a positive effect on breathing to be used as an adjunct to the Kime (turning and stopping hip) and Kiai (a cry of energy).
- There is a positive relation between abdominal muscles strength (Hara) and Vital capacity.
- There is a positive relationship between Gankaku Kata performance level and strength of abdominal muscles, static balance and vital capacity.

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