PHYSICAL TRAINING IN JUDO
INTRODUCTION
Physical training in judo: Where to start?
Physical training in judo: Optimization of sports performance

- Strength & Conditioning
  - Performance
  - Injury prevention
  - Weight management
- Muscle qualities (Max strength, Max power, S-P, Muscle Mass)
- VO2max
- Muscular endurance

Weight management
## Physical training in judo: Physical demands

<table>
<thead>
<tr>
<th></th>
<th>MAXIMUM STRENGTH</th>
<th>AEROBIC POWER</th>
<th>ANAEROBIC ENDURANCE</th>
<th>MAXIMUM POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEN</strong></td>
<td>1 RM between 1.32 and 1.5 x body weight</td>
<td>Between 47.3 and 59.3 ml/kg/min Aim for 60 ml/kg/min</td>
<td>No data on lactate in competition.</td>
<td>Correlation between the level of maximum power and the level of competition of judokas (departmental, regional, national (Favre-Juvin et al. 1989))</td>
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<tr>
<td><strong>WOMEN</strong></td>
<td>No data</td>
<td>Between 43.7 and 52.9 ml/min/kg Aim for 55 ml/kg/min</td>
<td></td>
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</tbody>
</table>

Studies with simulation of combat: Peak lactatemia = 18.12 ± 4 mmol / L

Aim for 60 ml/kg/min

Aim for 55 ml/kg/min

No data

No data on lactate in competition.
Reminder: Energy systems

The regeneration of the reserves of ATP and PCR is dependent on the aerobic power (VO2max).

Which of these energy systems (sources) are used in judo? In power? In endurance?
KEY FACTORS FOR NEUROMUSCULAR DEVELOPMENT
Key factors for neuromuscular development

Muscle size (hypertrophy level) + Nervous system (inter and intra-muscular coordination) = Maximum force level

Strength gain does not necessarily mean mass/muscle gain.
To increase strength, the central nervous system has three mechanisms:

1. Increasingly important recruitment motor units in a same muscle (spatial summation = 80% of maximum possibilities)

2. An increase of the discharge frequency of already activated units (temporal summation = 20% of maximum possibilities)

3. Better relaxation-contraction synchronization between agonist and antagonist muscles = better efficiency of movement.

Quality of nerve command

= Number of recruited motor units in the same muscle.
Structural factors

- The nature of the muscle fibres that constitute the motor units. Fibre type I, IIa, IIb.

- The cross-sectional area of the fibres and all the muscles required (number of myofibrils and contractile myofilaments per mm² of section).

- The state of shortening or stretching of the muscle.

*Hypertrophy = Strength gain by volume gain*
## Structural factors

<table>
<thead>
<tr>
<th></th>
<th>FIBRES ST I</th>
<th>FIBRES FTA IIA</th>
<th>FIBRES FTB IIB</th>
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<tr>
<td>DIAMÈTRE / DIAMETER</td>
<td>Faible / Low</td>
<td>Important / Important</td>
<td>Important / Important</td>
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<td>COULEUR (MYOglobine) / COLOR (MYOGLOBIN)</td>
<td>Rouge (élevée)</td>
<td>Rose (intermédiaire)</td>
<td>Blanche (faible)</td>
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<tr>
<td></td>
<td>Red (high)</td>
<td>Pink (intermediate)</td>
<td>White (low)</td>
</tr>
<tr>
<td>VASCULARISATION / VASCULARIZATION</td>
<td>Importante / Important</td>
<td>Intermédiaire / Intermediate</td>
<td>Faible / Low</td>
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<td>PROPRÉTÉS CONTRACTILES / CONTRACTILE PROPERTIES</td>
<td>Faible et longue / Low and long</td>
<td>Intermédiaire / Intermediate</td>
<td>Forte et brève / Strong and brief</td>
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<td>ACTIVITÉ ATPASIQUE / ATPASIC ACTIVITY</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>SOURCE ATP / ATP SOURCE</td>
<td>Oxydation / Oxidation</td>
<td>Glycolyse / Glycolysis</td>
<td>Glycolyse / Glycolysis</td>
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<td>ENZYMES ANAÉROBIES / ANAEROBIC ENZYMES</td>
<td>Faible / Low</td>
<td>Intermédiaire / Intermediate</td>
<td>Forte / Strong</td>
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<tr>
<td>FATIGABILITÉ / FATIGABILITY</td>
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<td>++</td>
<td>+++</td>
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<tr>
<td>ENZYMES KREBS / KREBS ENZYMES</td>
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<td>++</td>
<td>+</td>
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<tr>
<td>NBRE MITOCHONDRIES / NO. MITOCHONDRIA</td>
<td>+++</td>
<td>++</td>
<td>+</td>
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<tr>
<td>MÉTABOLISME / METABOLISM</td>
<td>Aérobie / Aerobic</td>
<td>Mixte (A + G) / Mixed (A + G)</td>
<td>Glycolytique / Glycolytic</td>
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</table>
Beginners: increasing strength is primarily due to the development (improvement) of **neural factors**

5-6 weeks training
WORK ZONE FOR MAXIMUM STRENGTH AND HYPERTROPHY
Charges too low to cause significant hypertrophy.
Reminder of the different types of contraction

- **Force concentrique / Concentric strength**
- **Force excentrique / Eccentric strength**
- **Force maximale Isométrique / Maximum isometric strength**

**Speed**
STRENGTH OR POWER QUALITIES TO DEVELOPED IN ATHLETES
Strength or power qualities to develop in athletes

Most important for Judo

- Maximum strength
- Strength-Power
- Maximum power
- Speed-Power
- Explosiveness
Example of the choice of loads for different work zones (max strength, hypertrophy, maximum power...)

Curve can be obtained with GYMAWARE encoders that measures speed with different weights.
Muscle adapts to the loads at which it is trained

Muscle adapts to the speed at which it is trained

Comparative effects of explosive training and heavy weight training on the strength - time and strength relationship – IEMG (Häkkinen 1985)
Strength-Speed profil

Endurance strength and hypertrophy: impact on the strength-speed curve

After the training
(if no maintenance for speed training)
Maximum strength: impact on the strength-speed curve

Important strength increase

After the training
(if no maintenance for speed training)
Adaptations are mainly made to the intensities worked.
Weightlifting : impact on the strength-speed curve

Strength-Speed profil

Heavy bench pull
– Squat: strength exercises

Weightlifting work areas: technical and semi-technical exercises

Less adaptation to maximum speeds without resistance
# Summary - Strength or power qualities to develop in athletes

<table>
<thead>
<tr>
<th></th>
<th>Force Maximale / Maximum Strength</th>
<th>Force-Hypertrophie / Strength-Hypertrophy</th>
<th>Hypertrophie / Hypertrophy</th>
<th>Puisance Force / Strength Power</th>
<th>Puisance Maximale / Maximum Power</th>
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</thead>
<tbody>
<tr>
<td>% 1 RM / %1 MR</td>
<td>90 à/to 100%</td>
<td>80 à/to 90%</td>
<td>80 à/to 60%</td>
<td>50 à/to 70%</td>
<td>40 à/to 50%</td>
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<td>NOMBRE DE RÉPÉTITIONS PAR SÉRIE / NUMBER OF REPEATS PER SERIES</td>
<td>5 à/to 2</td>
<td>8 à/to 5</td>
<td>12 à/to 8</td>
<td>It is the decrease in speed that determines the number of repetition</td>
<td></td>
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<tr>
<td>NOMBRE DE RÉPÉTITIONS PAR SÉANCE / NUMBER OF REPEATS PER TRAINING</td>
<td>Max 20</td>
<td>Max 25 à/to 30</td>
<td></td>
<td>Determined by the decrease in speed</td>
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<td>NOMBRE DE SÉRIES SUR LE MÊME GROUPE MUSCULAIRE / NUMBER OF SERIES ON THE SAME MUSCLE GROUP</td>
<td>3 à/to 10</td>
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<td>Determined by the decrease in speed</td>
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<tr>
<td>TEMPS DE RÉCUPÉRATION / RECOVERY TIME</td>
<td>Long 4 à/to 5 min</td>
<td>3 à/to 4 min</td>
<td>Short 1 to 2 min</td>
<td>Long 3 à/to 5 min</td>
<td></td>
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<tr>
<td>JUSQU'À L'ÉCHEC POUR LES DERNIÈRES SÉRIE? / UNTIL FAILURE FOR THE LATEST SERIES?</td>
<td>Yes, but not always</td>
<td>Yes, but not always</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Training frequency, overcompensation and rest

Average time for overcompensation on the same muscle group:
- 2 to 3 days: Muscular endurance and hypertrophy
- 2 days: Max strength
- ½ to 1 day: Power and Max speed

Work

Delay effect

Effect right after

Recovery

Overcompensation

Baseline

Passeleuvre 2007
Is weight training dangerous?

Weight training epidemiology and injury prevention

Principal cause of injury/lesion

No if you:
- Don’t neglect the warm-ups
- Use of proper technique for each exercise
- Progressive loading
- Proper monitoring of fatigue
STRENGTH TRAINING FOR CHILDREN AND TEENAGERS
We wait often to say:
« Strength training limits growth».  
« Strength training hurts your back».

WRONG

➤ Only if the training movement technique is not well done and if the loads, the movements and the objectives are not adapted.
Does Training Affect Growth?

Robin M. Daly, Shona Bass, Dennis Caine & Warren Howe

IN BRIEF: Adolescent athletes may be at risk of restricted growth and delayed maturation when intense training is combined with insufficient energy intake. Because catch-up growth commonly occurs when training is reduced or ceases, final adult stature is unlikely to be compromised. However, in athletes who have long-term, clinically delayed maturation, catch-up growth may be incomplete. By charting individual growth patterns, physicians, coaches, and athletic trainers can detect vulnerable periods when the training intensity should be reduced and energy intake may need to be increased.
Strength training for children and teenagers

- At what age can you start strength training?
- What are the precautions to take?
- What type of work should be offered based on age?
- What progress should we follow? At what dose?
Summary of various strength development factors possible to apply based on biological age (in the diagram, the size of the letters used is related to the importance of the factor described).
At what age can you start?

**Chronological age VS Biological age**

- Maturation
- Motor skills
- Physical and mental abilities

It is therefore the **biological** age of the child that will determine the objectives of the physical preparation work.
Development of strength during growth

Increase maximal of the max strength:
- Girl: 11,5 à 12,5 years
- Boy: 14,5 à 15,5 years (Bar-Or 1989)

Stabilisation of the max strength:
- Girl: 18 years
- Boy: between 20 and 30 years

Tiré de Ratel et Martin, 2014. L'enfant et l'activité physique de la théorie à la pratique
What type of training should we offer based on age? - 1/3

**Before puberty:**

– The development of strength will be done through the solicitation of the **nervous factors**.

– If it is possible to develop strength using conventional weight training programs made from guided devices (to see), it is more appropriate to use circuits (motor circuit) during which will be worked the speed, the motor coordination (simple), balance. **It is essential to keep a playful aspect when carrying out these circuits.**

– At the level of the energy sectors, the anaerobic alactic work (sprint, jump, ...) and aerobic are not problematic. However, it is advisable to avoid the work of lactic type (not impossible but strongly discouraged because of the difficulty to support this type of effort).

**Warning:** **During childhood and adolescence the bone system is fragile.**
During puberty (beginning):

– Emphasize the development of nerve factors but start learning the basic movements of strength training (no load or very light load).

– Implementation of circuit training using the weight of the body, elastics and light loads.

– This is a time for the development of speed (speed of reaction, acceleration capacity, speed of coordination and speed endurance) and coordination.

The peak of growth is a phase where one observes a deterioration of the flexibility, it is thus important to work this quality but without overloading the passive musculoskeletal system.
1. The growth peak at the end of puberty is the ideal period for the development of strength in both structural and nervous factors.

2. The growth peak is a favourable phase to the development of muscle qualities. However, ones need to be careful if during this period the muscles have a high degree of "drivability“ because the effort is less well supported by the passive musculoskeletal system *(No work in maximum strength, no loaded squat).*

3. At the end of puberty, if the learning process and progress have been well done, the work of developing maximum strength can be approached safely.
Practical recommendations:

1. Strength training programs, and those for the development of energy, must be offered by qualified professionals who have a teaching experience with children.

2. A 10-minute warm-up that includes aerobic and stretching exercises is required before any strength workout. (Dynamic stretching, exercise without load at large range of motion).
What are the precautions to take? - 2/2

Practical recommendations:
3. The first strength training sessions must be directed towards a technical work, and in particular towards the work of placement and posture, this on various muscular reinforcement devices with very slight loads to zero (work body weight or assisted work).
4. Never increase the loads until the technique is perfectly mastered
5. Adapt the program to the child's biological age
6. Always work agonist and antagonist muscles to not create muscle imbalance.
What progress should we follow? At what dose? - 1/2

- Exercises for an initiation program for children (and adults!)
  - Body weight
  - Elastics
  - Medicine balls
  - Swiss balls
  - Light weights

- Programs must consist of:
  - Basic exercises (multi-articular)
  - Basic exercises (strengthening of the shoulder and pelvic belts)
  - Core strength

- Major muscle groups need to be engaged with a full-articular range of motion.

- Use loads allowing 10 to 12 repetitions (60%-70% of the load allowing a single maximum repetition: 1MR)

- Each exercise (max 8) has a maximum of 2 to 3 sets of 10 to 15 repetitions.
What progress should we follow? At what dose? - 2/2

- Training load must be gradually increased throughout the program by:
  - Intensity (mass)
  - Number of repetitions
  - Number of series.

- Frequency of 2 to 3 non-consecutive workout/week to develop strength

- Recovery time between exercises:
  - Children: lower muscular fatigability = shorter recovery
  - Teenagers: equal to adult

- Combine muscular reinforcement with specific sports work = better transfer of strength in the sport gesture.
Training for beginners should consist of basic exercises (core ...) and educational basic exercises.

<table>
<thead>
<tr>
<th>BASIC EXERCISES</th>
<th>EXERCICES FONDAMENTAUX</th>
<th>EXERCICES COMPLÉMENTAIRES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic bodybuilding</td>
<td>Sheathing and fixation of the spine. Essential for initiation.</td>
<td>Impact localisé</td>
</tr>
<tr>
<td>Sometimes complex learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squat</td>
<td>Reverse crunch</td>
<td>Quadriceps bench</td>
</tr>
<tr>
<td>Leg press</td>
<td>Crunch with legs on bench</td>
<td>Larry Scott</td>
</tr>
<tr>
<td>Bench press</td>
<td>Torso rotation</td>
<td>Triceps pushdown</td>
</tr>
<tr>
<td>Neck press</td>
<td>Back extension on bench without weight</td>
<td>Wrist flexion and extension</td>
</tr>
<tr>
<td>Behind the neck lat pull-down</td>
<td>Plank</td>
<td>Rowing</td>
</tr>
</tbody>
</table>
Exercises classification and strength training for beginner

Good transfer of strength

= Proper coordination of the muscles composing the different muscular chains

Physical preparation should begin with:
- strengthening the trunk (core)
- strengthening the scapular
- strengthening pelvic belts
Circuit Training in the gym (program)

- Circuit training or **alternating** series program by workstation (vertical):
  - Interesting for the presentation of the exercises (discovery and technical training without fatigue)
  - Easier to set up with training groups.

- Circuit training or series program grouped by **workstation** (horizontal):
  - Interesting for the consolidation of the technical training of the exercises.

- Circuit training series **Mixed**
  - Program in bundled series incorporating super-series or tri-series.
Example of exercises for children - 1/2
Example of exercises for children - 2/2
EXAMPLE OF EXERCISES
Example of exercises
Example of exercises: Core exercises
Example of exercises: Proprioception exercises

- On one leg:
  - Open eyes
  - Eyes closed

- Unstable platform:
  - Cousin
  - BOSU
  - Swiss ball
  - Balance board ...
Example of circuit training alternating series for young and recreational judokas

Per exercise or number of repetitions (10 to 15 per series). Between each circuit, X minutes of recovery (X = number of circuit laps).

Always respect the right technique

Ex: 20s work/10s rest time between exercises
Example of circuit training alternating series with proprioception and specific exercises

If placed into a training, ideally do the circuit at the end of the training.
Example of circuit training alternating series in the gym

- The circuit is followed by 2 minutes of rest and repeated 3 to 4 times. Always prioritize the technique and not the load.

- Work with a Kinesiologist to develop programs if you are not trained yourself in physical preparation.
Strength training fundamentals

Bodybuilding epidemiology and injury prevention, Ivan Prothoy and Sylvain Pelloux-Prayer, 2015 Elsevier Masson

Back and shoulder placement
Strength training fundamentals: Exercises for shoulders posture correction (shoulder leaning forward)

External shoulder rotators

1
2
3
Strength training fundamentals: The plank – Fundamental core exercise

- Épaules à la verticale des coudes et éloignés des oreilles
- Cambrure naturelle
- Genoux fléchis
- Regard vers le sol
- Nombril aspiré

Hyperextension
Rolled shoulders
Pelvis to high
Strength training fundamentals: Sit-up straightening (rectus abdominus)

1

2

3 ➔ Progression for sit-up
Strength training fundamentals: Bench press - 1/3

Shoulders fixed to the bench and distant to the ears

Bar too high, shoulders not fixed
• Fixing the shoulders to the bench may cause back arching, but the gluteal should never be off the bench.
• If this happen, put the feet on a step.
Caution: People with a narrow rib cage and long forearms are more likely to get injured when working at maximum strength.
Strength training fundamentals: Low pulley pulling

Be careful with the placement of the shoulders.
Strength training fundamentals: High pulley pulling

Solution: chest pull on the high pulley, stand with your back to the station.
Strength training fundamentals: Exercises for the positioning of the back.
Strength training fundamentals: Squat - 1/3

Alignement pointe des pieds-genoux-hanchés

Alignement tête – épaules - bassin

Recul des fesses et avancée des genoux

Poids du corps et de la barre répartis sur l’ensemble du pied
Athlete with long femur will have to lean more forward which leads to greater stress at the lumbar level.

Maintain the natural curve of the back by adjusting the placement of the pelvis.
Postural learning (retroversion in pelvis anteversion)
Front squat:
  o Flexibility of the posterior chain

What range of motion for the squat? Complete, ½, ¼
Strength training fundamentals: Deadlift

Classical mistake, pelvic and shoulder rolling
Strength training fundamentals: Other common mistakes

- **Rowing**
- **Lunges**
- **Neck press**
- **Biceps**
- **Triceps**

Photos illustrate the common mistakes in these exercises.
Strength training fundamentals: Exercises for shoulders posture correction.

Image from the book: Strength training Anatomy by Frédéric Delavier
AEROBIC AND ANAEROBIC POWER TRAINING AND ASSESSMENT
Aerobic power training and assessment: Aerobic power tests

1. University of Montreal Test (Léger-Boucher) over 200m or 400m track
2. 20 m shuttle test
3. Indirect treadmill test (use the Léger-Boucher protocol)
4. ½ Cooper (Greater distance in 6 minutes)
Aerobic power training and assessment: Aerobic power tests

1. University of Montreal test (Léger-Boucher)
   - Speed at Level 1 = 7km/h
   - The level stage time is 2 min
   - The speed increases by one km/h every 2 minute for each stage level
   - The cones are placed every 50 m

2. 20 m shuttle test
   - Speed at Level 1 = 8km/h
   - The stage level time is 1 min
   - The speed increases by 0,5 minute for each stage level

3. Indirect treadmill test (use the Léger-Boucher protocol)
### Aerobic power training and assessment: Shuttle test speed conversion table in MAS

<table>
<thead>
<tr>
<th>Level</th>
<th>Shuttle test speed (km/h)</th>
<th>VO2 max (ml/kg/min)</th>
<th>Regular speed on a track (km/h)</th>
<th>Speed (km/h)</th>
<th>VO2 max (ml/kg/min)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>8,5</td>
<td>23,6</td>
<td>8,5</td>
<td>7</td>
<td>24,5</td>
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<td>26,6</td>
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<td>18,7</td>
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</table>
Aerobic power training and assessment

Effect of different training intensities on the development of aerobic power and aerobic endurance and anaerobic lactic endurance.

<table>
<thead>
<tr>
<th>Training Intensity (% MAP)</th>
<th>Anaerobic Capacity</th>
<th>Maximal Aerobic Power (MAP)</th>
<th>Aerobic Endurance</th>
</tr>
</thead>
<tbody>
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<td>110%MAP</td>
<td>++++</td>
<td>++</td>
<td>+++</td>
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<td>105%MAP</td>
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<td>45%MAP</td>
<td>+</td>
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</tbody>
</table>

Table 1

+++++ Max effect
++++  Very strong effect
+++   Strong effect
++    Medium effect
+     Low effect
Aerobic power training and assessment: Training examples in aerobic power by Guy Thibault
Aerobic power training and assessment

Short intervals:
- VO2max is increasing faster
- Lactic anaerobic capacity increases for higher effort
  100 % of the MAS or the PMA
- More effective for weight management because it causes greater energy exertion
The 30-second run:

- Goal: run the greatest possible distance in 30 seconds.
- Instructions: on a 30 m course, the subject makes round trips and must cover the greatest possible distance.
- The results measure the distance traveled and the average speed of the run.
- Interpretation: The test is strongly correlated with the average working power supplied in the Wingate test.

No standard, only to compare the progress of the same person.
(30s shuttles + 35s recovery) x 6:
- This test is to run the greatest possible distance in 30 seconds running back 5 then 10 then 15 then 20m .... It calculates the total distance traveled in 30 seconds.
- During recovery of 35s, you have to return to the starting line. This sprint of 30 seconds is repeated six times.
Main problem of these different tests for the evaluation of the lactic capacity of judokas:

- These tests are carried out with the help of the lower limbs while in judo the muscles that will apply the most the anaerobic lactic chain are the muscles of upper limbs.
Conclusion

**Competitive Judo:**
- Increase muscle qualities:
  - Maximal strength
  - Maximal power and Strength-Power
  - Muscle Mass
- Injury prevention.
- Development of VO2max (increasing the capacity of recovery between short high intensity drill).
- Development of muscular endurance (fatigue resistance during exercise using the anaerobic pathways).
- Weight management.

**Recreational judo**
- Goal of physical work = injury prevention
  - Dojo circuit may be sufficient
  - For children, alternating circuit training series (vertical)
*French book
– Terzi P. and Passelergue Ph. Form notebooks n ° 3. The teaching of bodybuilding, CREPS of Dijon.
– Epidemiology bodybuilding and injury prevention, Ivan Prothoy and Sylvain Pelloux-Prayer, 2015 Elsevier Masson
– Guide to bodybuilding movements, Frédéric Delavier, 5th edition, Vigot
Thank you!