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Dr. Jean Julia , F

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Physical exercise, tool for prevention and treatment

Introduction

I'm not going to make the case for sport in this talk. I would just like to give you a few pointers which show that a reasonable exercise programme improves the health of certain individuals and of the population as a whole.

My teachers taught me that my future depended on genetic factors (which we tend to under-estimate) and also on environmental factors. We are the descendants of prehistoric man who spent his energies finding food. A sedentary lifestyle is not inscribed in our genes, nor allowed for in our behavioural evolution. This explains its detrimental effects on numerous bodily organs and metabolism.

This sedentary life-style has 2 principal effects:

- a decrease in muscular strength [1]
- becoming overweight (also a consequence of eating badly)

This has numerous consequences: an increase in cardio-vascular and respiratory diseases, obesity, cancer, arthritis, osteoporosis and even an acceleration in the ageing process.

We are therefore going to analyse the effects of physical activity on the prevention and treatment of these pathologies [2], since it is certainly due to these mechanisms that Prof. St-Blain was able to affirm at the Monaco meeting in 2007: "Active people live 3 years longer than people who are moderately active and they in turn live 6 years longer than those who are sedentary".

Before embarking on the purely technical aspect of my thesis, I would like to talk a little about the approach which will allow a patient to be motivated to increase their physical activity. [3]

We will need to start by getting to know at what level the patient is active, what he is used to doing, what he knows and what he believes about exercise:

- What is wrong with him?
- What does he do?
- What does he know?
- What is he?
- What does he plan to do?

Then, we will need to assess the level of motivation to change of the patient, basing ourselves on Prochaska's theory which comprises 5 stages:

- Indifference (where the subject has no intention of changing)
- Reflection (where the subject is thinking about becoming more active)
- Action (where the subject starts or is going to start making changes)
- Action (where the subject is doing enough physical exercise)
- Maintenance (where the subject has integrated their exercise routine into their daily life)

*knowing that progression through the stages is more cyclical than linear and the person can go backwards one or more stages.

Finally, knowing our subject, knowing their level of motivation to change, we can envisage giving them advice.

This advice could be;

- Stage 1 – encourage them to change
- Stage 2 – reinforce the benefits of exercise and the risks of not doing so
- Stage 3 – propose a precise plan, mentioning the possible barriers to maintaining it and traps to avoid
- Stages 4 and 5; diversify the suggested activity, prioritise group exercise, warn of set-backs, identify and talk about the benefits already realised.

1 OVERWEIGHT AND PHYSICAL ACTIVITY

Overweight and even more so, obesity results in a decrease in aerobic capacity (almost certainly because of a decrease in physical activity and the syndrome of deconditioning) which increases cardiovascular risk. Therefore, the priority is to take up a physical activity, which, by reducing insulin resistance (but not exclusively by this mechanism: the increase in energy expenditure allied to the effort of exercise, an increase in muscle mass and therefore of metabolism at rest) will have an effect on the excess weight and on the factors which increase cardiovascular risk. The objective is not to look like skinny models in the magazines, not forgetting that 'a fat man who moves has a lower mortality than a normal person who doesn't move.'

1.1 CALCULATING EXCESS FAT

I will pass rapidly over the methods to calculate excess body fat

- Body mass index (BMI; weight over the square of height)
- Waist measurement. In fact, this reflects more precisely the abdominal fat which has worse effects than fat at the level of the hips notably because its greater propensity to liberate fatty acids into the circulation
- Metabolic syndrome which is the association between obesity and at least 2 of the following factors: raised triglycerides, decreased HDL cholesterol, hypertension, type 2 diabetes.

1.2 PATHOPHYSIOLOGY

This excess fat is due to genetic and behavioural factors; a sedentary lifestyle and disturbed eating habits. It is also important to mention that appetite is regulated differently depending on whether one is sedentary or active [4];

- In sedentary people (where outgoings in all senses of the term are reduced!), the appetite is mainly regulated by extrinsic factors (the availability and attractiveness of food)
- In active people (where activity increases the 'outgoings'), the appetite is principally regulated by intrinsic factors; by real need.

1.3 CALCULATING ENERGY EXPENDITURE

How do we calculate energy expenditure?

- In kilocalories (Kcal)
- Or in MET (Metabolic Equivalent Task) where 1 MET corresponds approximately to the energy expenditure of a person at rest.

*we need to know that there is a relationship between the two; the energy expenditure in Kcal/min of a physical activity = the energy expenditure in MET x 3.5 x weight / 200.

In MET, the energy expenditure of various activities is defined as follows;

• Light activity	3 MET	walking at 3km/hour playing the piano
• Moderate activity	3-6 MET	walking at 5-7km/hour Bicycling (at 10-16km/hour) Golf (3 MET) Skating (6 MET)
• More intense exercise	>6 MET	walking at 8km/hour (6 MET) Running >10km/hour (≥10 MET) Bicycling at 18km/hour (6 MET) Bicycling at 22km/hour (8 MET) Tennis (6 MET) Squash (10 MET or more)

1.4 ADVICE ON PRESCRIBING EXERCISE

By the method RASP: regular, adapted, safeguarded, progressive.

1.4.1 Normal weight person

- 30 minutes (all in one or 3 times 10 minutes) moderate exercise 5 times/week, such as walking fast
- 20 minutes (all in one or 2 times 10 minutes) more intense exercise, such as football 3 times a week, muscle training on 2 non-consecutive days in the week (10 repetitions of the same movement covering 10 different muscle groups)

1.4.2 Overweight person (2008; INSERM report)

To prevent putting on weight, an obese or overweight person needs to do 45-60 minutes, 5 times a week of moderate activity, such as walking or bicycling without significant shortness of breath.

To lose weight, it is better to individualise the exercise prescription

- Based on the mVO2
- Based on Lipoxmax: this is a method developed by Prof. Mercier at Montpellier which calculated the point of exercise when lipid oxidation is at its maximum. (The point at which

energy provided by glycaemic oxidation exceeds that provided by fatty acid oxidation is called the Cross Over Point; below this exercise intensity fat is preferentially metabolised.)

Lipoxmax protocol:

- Perform an exercise protocol in stages (measuring gas exchange and heart rate)
- At each stage calculate the respiratory quotient (VCo2/VO2). We know that when this is at 0.7 the body is metabolising lipid preferentially.

2 PHYSICAL ACTIVITY AND CARDIOVASCULAR DISEASE

Physical activity reduces cardiovascular mortality by at least 20% principally by correcting risk factors; high blood pressure, dyslipidaemia, non-insulin-dependent diabetes, thrombogenic factors in particular platelet aggregations and by increasing cardiac reserve and the capacity of muscles to extract oxygen. The ultimate effect of these adaptations is to reduce myocardial ischaemia.

2.1 PREVENTION

Physical exercise prevents the formation of coronary atheroma and the development of hypertension [5] and reduces the progression of coronary disease [6], and of atheroma in the leg arteries [7] and heart failure [8].

2.2 HOW TO PRESCRIBE PHYSICAL ACTIVITY IN CARDIAC PATIENTS

2.2.1 General principles

Specify the type, duration, frequency and intensity of exercise
The intensity can be calculated based:

- Either on heart rate

For primary prevention it is sufficient to calculate the intensity

- as a function of % peak heart rate according to the formula 220-age or according to Karvonen's formula which takes into account the heart fate at rest and the % peak heart rate (exercise heart rate-resting heart rate/ the difference between resting and peak heart rate).
- Or according to the 6 minute walk test or Luc Leger's test protocol which consists of asking the person to do the greatest possible number of to and fro between two markers 20m apart getting gradually faster.

For secondary prevention the prescription needs to be based on the heart rate measured during an exercise protocol.

- Either on the Rate of Perceived Exertion self-reported by the patient as a point on the Borg score which quantifies how difficult the patient is finding it to do the exercise ; the score goes from 6-20 and rates 6-11 as easy, 12-15 as difficult and 16-20 as very difficult.
- Or on the energy expended expressed as MET

2.2.2 In practise – primary prevention

For a **sedentary** person, I propose small objectives (case D);

- 1st month ; walk 20 minutes three times a week ; park 15 minutes walk from work, do 30 minutes fast walking once a week

- 2nd month ; (after check-up): add 20minutes three times a week of fast walking or bicycling (until breathless and finding it slightly difficult to talk), then increase gradually the length, frequency and intensity and introduce gentle muscle training.

If the person is more **active**, I increase the speed of progression in intensity and duration of training.

2.2.3 In practise – secondary prevention

For secondary prevention, I prefer to give an individualised prescription based on resting ECG, echo (cardiac ultra-sound) and above all exercise testing.

- The patient must know their illness to look out for any resulting symptoms
- Attention should be paid to contra-indications; unstable angina, rhythm disturbance or hypertension, poorly controlled heart failure, tight aortic stenosis, acute illness.

a) For an overweight, hypertensive person;

If **sedentary**, (the case of FC), the exercise test allows the calculation of

- Oxygen consumption at each level of exercise identified by a given heart rate up to the patient's maximum which is his VO2 max.
- His energy consumption calculated from the oxygen consumption

I prescribe;

- Exercise at 40-70% VO2 max
- 3-7 times a week
- Lasting 30-60 minutes
- Expenditure of 700-2000 kcal/week

For an **active person**, I increase the intensity, duration and frequency of the sessions

For a **post coronary patient** one has to be careful and the exercise programme needs to be adapted according to how long since they were in hospital;

- Convalescence (in a rehabilitation centre) 3-6 weeks
- Maintenance ; regaining normal activities
- Eventually arrive at 60 minutes per day, 3-4 times a week, at an intensity which depends on the state of the patient's coronaries, with a prescription either:
  - As a function of heart rate (minimum 40-50% VO2 max); or
  - Heart rate 10 bpm below the heart rate at which clinical symptoms or ECG changes signifying ischaemia appear; or
  - Borg scale 13; or
  - As a function of MET (for it is often difficult to base the prescription on heart rate because of beta-blocker therapy.)

3 Is Exercise effective against cancer?

3.1 Cancer types

This seems to be proven in at least 2 cancers

a) Breast cancer

- Primary prevention: the incidence is decreased by 20% [9]
- Secondary prevention: an exercise programme increases 10 year survival by 5% and above all yields a better quality of life

b) Cancer of the colon
- Primary prevention: the incidence is decreased by 50% (this effect is independent of dietary factors which also have an important effect).
- Secondary prevention: small improvement

For other cancers (prostate, pancreatic…), there is very limited evidence, and for lung cancer regular exercise encourages the cessation of smoking which is itself a major risk factor for cancer.

3.2 What is the mechanism of action?

It seems to be a generalised effect with;

- An immunological hypothesis: an increase in cytochrome p450, macrophages and natural killer cells
- A hormonal hypothesis (INSERM 2008): regular exercise decreases intra-abdominal fat which contains significant amounts of oestrogen

(INSERM is the French National Institute of Health and Medical Research)

This hypothesis explains:

- The effect of physical activity on the survival of women with hormone sensitive cancers
- The little effect seen in the survival of women with a high body mass index

3.3 What exercise programme to prescribe?

Primary and secondary prevention:

- Colon cancer: there is no consensus, but one can suggest 30-60 minutes moderate exercise with mixed types of activity (aerobic exercise 3 times a week, muscle training 2 times a week). There is probably a dose-response effect.
- Breast cancer: there is a dose response curve (one shouldn't exercise more than 9-14 hours per week) for increased physical exercise of varying types.

4 Physical exercise and osteoporosis

Osteoporosis is characterised by low bone density and an alteration in the micro-architecture of bone which increases the risk of fracture.

4.1 Diagnosis

The precise diagnosis is made by bone densitometry.

4.2 Epidemiology

This affects about 35% post-menopausal women per year or about 4 million women and causes 130,000 fractures per year.

4.3 AETIOLOGY

This can be divided into

a) Primary:
   - Defect in the laying down of bone during childhood or puberty
   - Loss of bone after the menopause associated with ageing

b) Secondary:
   - Endocrine disease
   - Disease of the digestive system
   - Longstanding treatment with systemic steroids

4.4 PREVENTION

- Primary: physical activity increases bone mass in young women and decreases the bone loss in post-menopausal women as long as the exercise programme is sustained. [10]
- Secondary: physical activity decreases the incidence of hip fracture as much in men as it does in women.

4.5 PATHOPHYSIOLOGY AND RECOMMENDED EXERCISE REGIME

It is an illness whose roots lie in childhood (bone is mainly laid down around the time of puberty) and which manifests itself in old age, hence the necessity:

To undertake a variety of sporting activity in childhood and during adolescence (to increase the laying down of bone)

In adulthood, to keep physically active (to slow down the bone loss)

In the post-menopausal female and in the elderly male, to maintain impact exercise: and here speed walking as in 'Nordic walking' is strongly recommended, as

- By speeding up the speed of walking, it increases the strength of the lower limbs and minimises the risk of falls
- By increasing the impact, it increases bone density (the theory is that osteoblasts are sensitive to cyclical impact; mecano-receptors transform this mechanical information into a biological signal, the synthesis of bone). Added together, the risk of fracture is diminished.

NB. Before resorting to medication (and I'm not talking about calcium and vitamin D), whose side-effects are well known and whose effectiveness is rather weak, the most important thing is to remain physically active all one's life.

5 DOES PHYSICAL ACTIVITY PREVENT OR WORSEN ARTHRITIS?

Extrapolating a study done in the US and published in 1989, one can estimate that in France there are 9-10 million sufferers with arthritis with, in decreasing order of frequency of joint affected: arthritis of the knee, the hip, fingers and spine. Sometimes the disease results in joint replacements: amongst those 75 years and older, 8% have had a total hip replacement, 3% have had a total knee replacement.

If one remembers that 70% arthritis appears after the age of 50, then one can imagine that the numbers are only going to increase.

Arthritis is not a physiological ageing of cartilage, but an illness which can either be

- Primary with abnormal cartilage; or
- Secondary with normal cartilage [11], but either:
    - Subject to unusual pressure because of exercise that is too intense, overweight, a joint abnormality such as genu varum, or a joint instability such as rupture of the cruciate ligaments of the knee in association with a neuro-muscular disorder for example; or
    - Affected by disease:
        - rheumatic (chondrocalcinosis)
        - metabolic (haemochromatosis)

5.1 PATHOPHYSIOLOGY

Intermittent moderate physical activity such as walking or cycling without major impact or joint rotation stimulates the cartilage cells.

5.2 EPIDEMIOLOGY

Several studies have shown that:

- Rapid walking on joints with morphological abnormalities can be deleterious
- Immobilisation seems to be arthrogenic
- Free walking is to be recommended (but there is no formal proof of this)

5.3 PREVENTION

It is important to limit trauma to the joints by

- Receiving training in sport
- Physical preparation adapted to the sport being undertaken
- Moderate activity

At the level of the knee, physical exercise which combines endurance and quads training under partial load such as cycling, reduces the progressive loss of joint space.

The advice therefore is

- To maintain a healthy joint mobility
- To maintain general flexibility
- To maintain sufficient muscular strength

By means of a sensible and thought-out exercise programme: minimising joint impact and rotation, and trying to increase general muscle mass and in order to achieve this, favour soft surfaces and sport that is only partially weight-bearing, such as walking in woodland or cycling.

It is clear that it is better to avoid physical activity during a flare in joint inflammation and that exercise programmes need to be initiated by a physiotherapist who will give specific exercises designed to strengthen muscles however they are used, stretching exercises of several types, exercises to promote proprioception and balance and aerobic exercise.

After this, these exercises can be practised at home or at a gym supervised by an exercise instructor.

Example of exercise programme lasting 1 to 1.5 hours to be repeated 3-5 times a week:

- Warm-up (5-10 minutes)
- Aerobic exercise: walking on soft surface, cycle or aqua-cycle moving the joints, achieving about 2/3 maximum heart rate
- Muscle training (minimum twice a week, alone or in a group ideally open access), muscular work with elastic band, stretching, work on proprioception (Kleine ball).

When it comes to joint replacements (hip and knee), the greater the skill at sport prior to the joint replacement, the more likely it is the person will be able to play that sport with their prosthetic joint.

6 AGEING AND PHYSICAL ACTIVITY

Now, I'm going to talk about a very current issue, both because the population in France is getting older, but equally because it affects a number of us gathered here.

It is currently estimated that from the age of 65:

- 25% individuals retain full function
- 50% have diminished function
- 25% have marked disability because of chronic disease.

6.1 PATHOPHYSIOLOGY

6.1.1 Effects of ageing on cardiovascular function

With age, peripheral resistance increases which results in a rise in blood pressure and hence left ventricular hypertrophy

With age, coronary atheroma progresses (30% people older than 75 present with coronary disease)

So the heart muscle is bigger, less well perfused and we know that our aerobic capacity as a relexion of our general fitness alters with age; it diminishes by 10% every 10 years above the age of 20 and this decline accelerates above the age of 50.

6.1.2 Age and the locomotor apparatus

At the level of the bones, osteoporosis becomes significant

Muscular strength diminishes from the age of 50 by 10-20% every 10 years

6.1.3 Age and cognitive function

The decline in cognition can be slowed down by:

- Intellectual activity
- Social links
- Regular physical exercise
- (I haven't mentioned medication…)

6.2 THE EFFECT OF PHYSICAL EXERCISE ON AGEING [12]

6.2.1 Endurance training

Endurance training:

- Decreases muscle loss, which results in greater energy expenditure which in turn limits the increase in fat weight
- Diminishes the bone loss
- Maintains cognitive function
- From the cardiovascular point of view, regular training improves VO2 max by increasing cardiac reserve and oxygen extraction by peripheral muscle.

6.2.2 Resistance training

Resistance training, or rather muscular strengthening which keeps the joints supple and augments the reflexes, will lessen falls and therefore the risk of fractures which has huge consequences for the older person's independence and autonomy.

6.2.3 Physical exercise

Finally, physical exercise delays the onset of dementia, since "if the brain controls the hand, the hand stimulates the brain".

6.3 PRESCRIBING PHYSICAL EXERCISE

One must start by completing a check-list:

1. Clinical:
    - cardiovascular, looking for risk factors, checking for an aortic murmur, checking the peripheral pulses
    - check bones and joints
    - Check vision and hearing
    - Check risk of falling
2. Perform resting ECG and exercise test if the physical activity is intense, depending on terrain
3. Basic pathology

In terms of the check list, absolute contra-indications are rare (acute illness) and relative contra-indications are poorly controlled chronic disease.

What advice should one give?

- Alternate activity in a hall, in the open air , in the swimming pool
- Ban any spirit of competition
- Aim for congenial surroundings

Aerobic training must always be preceded by warm up and succeeded by cooling down (for example by stretching exercises). One might suggest:

- Either 30 minutes moderate exercise without getting breathless
- Or 10-20 minutes more intense exercise getting breathless three times a week

Muscle training which can be predominantly aerobic or anaerobic, depending on intensity, must always be done with warm up first and stretching at the end of the session. One can do the same movement 10 times on alternate days of 10 different muscle groups at half maximal effort (getting there gradually). It is useful for lateralisation (awareness of which side of the body you favour for certain activities), awareness of space, sense of rhythm, neuromuscular adaptation to new circumstances.

One can give certain practical advice, but patients will come above all for a certificate saying they do not have any contra-indications and perhaps for further examination. They ask one or two questions and rely principally on their experience and on the sport director at their club.

7 PHYSICAL EXERCISE AND TYPE 2 DIABETES [13]

Type 2 diabetes is due to insufficient production and utilisation of insulin.

I will gloss over its diagnosis (fasting glucose > 1.26g/l on 2 separate occasions) and its complications:

- Macro-angiopathy (coronary arteriopathy and peripheral vascular disease)
- Micro-angiopathy (retinopathy, nephropathy)
- Neuropathy (sensory and autonomic)

to say a word about its pathophysiology, the effects of physical exercise on diabetes and the exercise programme one might suggest.

7.1 PATHOPHYSIOLOGY

Over-eating and a sedentary life-style are responsible for insulin resistance which has a pro-inflammatory and pro-thrombotic effect

This insulin resistance is compensated to start with by an increase in the secretion of insulin, then the pancreas becomes exhausted and the diabetes becomes apparent.

7.2 THE EFFECTS OF PHYSICAL ACTIVITY

In 2008, Balkan from INSERM published the RISC study [14] which showed that regular physical exercise permitted insulin responsiveness to be retained. Several mechanisms of action were proposed:

- Maximising the capture of glucose by muscle (independent of insulin)
- Increasing the insulin sensitivity of muscle post-exercise
- Increasing the muscular blood supply reserve
- A decrease in visceral and subcutaneous abdominal fat

7.3 PROPOSED EXERCISE PROGRAMME

- Primary prevention
  - Initial check and review every 3 months for pre-diabetic subjects
  - Prescription of an increase in activity from base-line and aerobic activity 3 times a week
- Secondary and tertiary prevention
  - A minimum of 30 minutes 3 times a week of aerobic activity at 30-60% VO2 max calculated during an exercise test (corresponding to the lipoxmax)
  - Add in global muscular and suppleness training: work on 8-10 muscle groups with 10-15 repetitions of the same exercise for each muscle group 3 times a week (arriving at 50% maximal strength).

8 PHYSICAL ACTIVITY AND RESPIRATORY DISEASE

I will end with a few words on physical activity and respiratory disease.

8.1 ASTHMA

One can distinguish two clinical manifestations of asthma allied to activity:

- Firstly a type of asthma which gets worse with exercise
- Then asthma said to be exercise asthma which is in fact an asthma attack occurring 10-15 minutes after exercise.

These two clinical forms of asthma need to distinguished from the broncho-constriction induced by exercise in non-asthmatic individuals (due to local acidosis, which can go on to develop into asthma).

In asthma, sport is recommended changing the treatment if necessary, and only 10% patients need to adapt their exercise regime. *[15]*

In exercise-induced asthma and in broncho-constriction associated with exercise, it is usually sufficient to take a beta-agonist inhaler just before exercise.

8.2 CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

COPD is firstly a lung disease, then a disease of the muscles leading to deconditioning (the case of Mr …) *[16]*

The only effective treatment is to stop smoking and to do physical training.

I hope that these few thoughts will have convinced you of the importance of regular physical exercise…

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