5.2. Body composition

5.2.1. Body Mass Index (BMI)

Purpose	To measure body size.
Health relation	Higher BMI is associated with a worse cardiovascular profile.
Equipment	An electronic scale and a telescopic height measuring instrument.
Performance	Body weight in kilograms divided by the square of height in meters (kg/m^2).

Body weight

The child must stand on the platform of the scale without support. The child stands still over the centre of the platform with the body weight evenly distributed between both feet. Light underclothes can be worn, excluding shoes, long trousers and sweater.

Body height

Hair ornaments must be removed and braids must be undone. The child stands on the stadiometer with bare feet placed slightly apart and the back of the head, shoulder blades, buttocks, calves, and heels touching the vertical board. Legs must be kept straight and the feet flat. The tester must position the child's head so that a horizontal line drawn from the ear canal to the lower edge of the eye socket runs parallel to the baseboard (i.e., the Frankfort plane positions horizontally). The headboard must be pulled down to rest firmly on top of the head and compress hair.

Practice and number of test trials: Two measurements of both body weight and body height are performed and the mean of each one is retained.

Measurement	It starts when the child has reached the correct test position.
Scoring	Weight is recorded to the nearest 100 g. *Example:* a result of 58 kg scores 58.0. In height the reading must be taken to the last completed 1 mm. *Example:* a result of 157.3 cm scores 157.3.

5.2.2. Waist circumference

Purpose	To estimate central body fat.
Health relation	A higher waist circumference is a risk factor for cardiovascular disease.
Equipment	Non-elastic tape.
Performance	The child wears little clothing so that the tape may be correctly positioned. The child stands erect with the abdomen relaxed, the arms at the sides and the feet together. The tester faces the child and places an inelastic tape around him/her, in a horizontal plane, at the level of the natural waist, which is the narrowest part of the torso, as seen from the anterior aspect. In some obese children, it may be difficult to identify a waist narrowing. In such cases, the smallest horizontal circumference should be measured in the area between the spina iliaca superior and the costal edge in the midaxillary line. **Practice and number of test trials:** Two measurements are performed not consecutively and the mean is used in the analyses.
Measurement	It starts when the child has reached the correct test position. The measurement should not be made over clothing, should be taken at the end of a normal expiration without the tape compressing the skin and with child's arms at the side.
Scoring	It is recorded to the nearest 0.1 cm. *Example:* a result of 60.7 cm scores 60.7.

5.2.3. Triceps skinfold thickness

Purpose	To measure subcutaneous fat and to estimate percentage body fat.
Health relation	A higher adiposity is a risk factor for cardiovascular disease.
Equipment	Skinfold calliper, non-elastic tape and pen.
Performance	The mid-upper-arm point is half the distance between the acromion process (the most lateral bony protuberance of the back of the shoulder) and the olecranon (the bony structure that stands out when the elbow is bent). The tester stands behind the child and picks up the skinfold about 1 cm above the midpoint mark over the biceps muscle, with the fold running downward along the midline of the back upper arm. The caliper jaws must be applied at right angles to the "neck" of the fold just below the finger and thumb over the midpoint mark. While maintaining a grip on the skinfold, the tester gently releases the caliper handles and allows the jaws to close on the fat fold for two seconds before taking the reading. **Practice and number of test trials:** Two measurements are performed not consecutively and the mean is used in the analyses.
Measurement	Child starts when he/she has reached the correct test position. Skinfolds must be measured not on the dominant side of the adolescent (it means that, when someone is right-handed than skinfolds must be measured on the left-hand side). The measurement should not be made over clothing.
Scoring	It is recorded to the nearest 0.1 mm. *Example:* a result of 21.2 mm scores 21.2.

5.2.4. Subscapular skinfold thickness

Purpose	To measure subcutaneous fat and to estimate percentage body fat.
Health relation	A higher adiposity is a risk factor for cardiovascular disease.
Equipment	Skinfold calliper, non-elastic tape and pen.
Performance	The subscapular skinfold is picked up on a diagonal, inclined infero-laterally approximately 45° to the horizontal plane in the natural cleavage lines of the skin. The site is just inferior to the lower angle of the scapula. The child stands comfortably erect, with the upper extremities relaxed at the sides of the body. To locate the site, the tester palpates the scapula, running the fingers inferiorly and laterally, along its vertebral border until the inferior angle is identified. For some children, especially the obese, gentle placement of the child's arm behind the back aids in identifying the site. The caliper jaws are applied 1 cm infero-lateral to the thumb and finger raising the fold. **Practice and number of test trials:** Two measurements are performed not consecutively and the mean is used in the analyses.
Measurement	Child starts when he/she has reached the correct test position. Skinfolds must be measured not on the dominant side of the adolescent (it means that, when someone is right-handed than skinfolds must be measured on the left-hand side). The measurement should not be made over clothing.
Scoring	It is recorded to the nearest 0.1 mm. *Example:* a result of 33.4 mm scores 33.4.

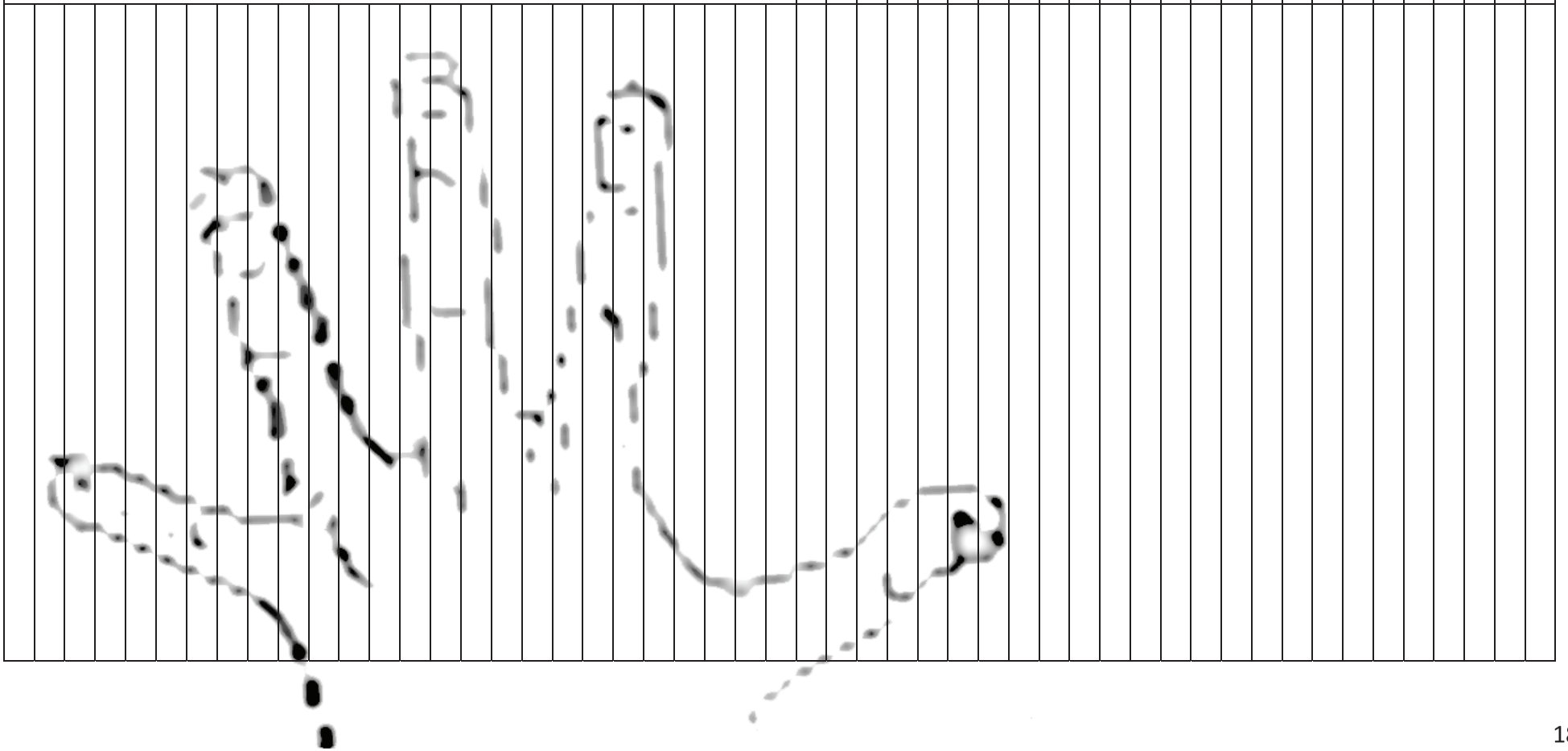
5.3. Musculoskeletal fitness

5.3.1. Handgrip strength

Purpose	To measure upper body isometric strength.
Health relation	Musculoskeletal fitness is inversely associated with established and emerging cardiovascular disease risk factors, back pain and with bone mineral content and density. Musculoskeletal improvements from childhood to adolescence are negatively associated with changes in overall adiposity.
Equipment	A hand dynamometer with adjustable grip (TKK 5101 Grip D; Takey, Tokio Japan) and a table-rule.
Performance	Child squeezes gradually and continuously for at least 2 seconds, performing the test twice (alternately with both hands) with the optimal grip-span (previously calculated, according to the hand size) and allowing short rest between measures. For each measure, the hand to be tested firstly is chosen randomly. The elbow must be in full extension and avoiding contacting with any other part of the body with the dynamometer, except the hand being measured. **Instructions:** "Take the dynamometer with one hand. Squeeze it forcefully as you can while holding the dynamometer away from your body. Don't let it touch you during the test. Squeeze gradually and continuously for at least 2 seconds. Do the test twice per hand: the best result scores." **Practice and number of test trials:** The tester shows the right performance. Both hands are to be tested twice, and the best result (of each hand) scored. Adjust the hand grip span according to the hand size (see next page).
Measurement	The maximal duration of the test is 3-5 seconds. Hand size should be measured in right hand at maximal width and by measuring the distance separating distal extremes of the first and fifth digits. The precision of the measure is 0.5 cm. The results of hand size should be rounded to the nearest whole centimetre. If you prefer, you can put the children's hand over the ruler-table to see the optimal grip span according to hand size (see ruler-table). During the test, the arm and hand holding the dynamometer should not touch the body. The instrument is held in line with the forearm and hangs down at the side. After a short rest, a second attempt is made. The indicator needs to be returned to zero after the first attempt.
Scoring	The result is expressed in kilograms, accurate to 0.1 kg. *Example:* a result of 24 kg scores 24.0.

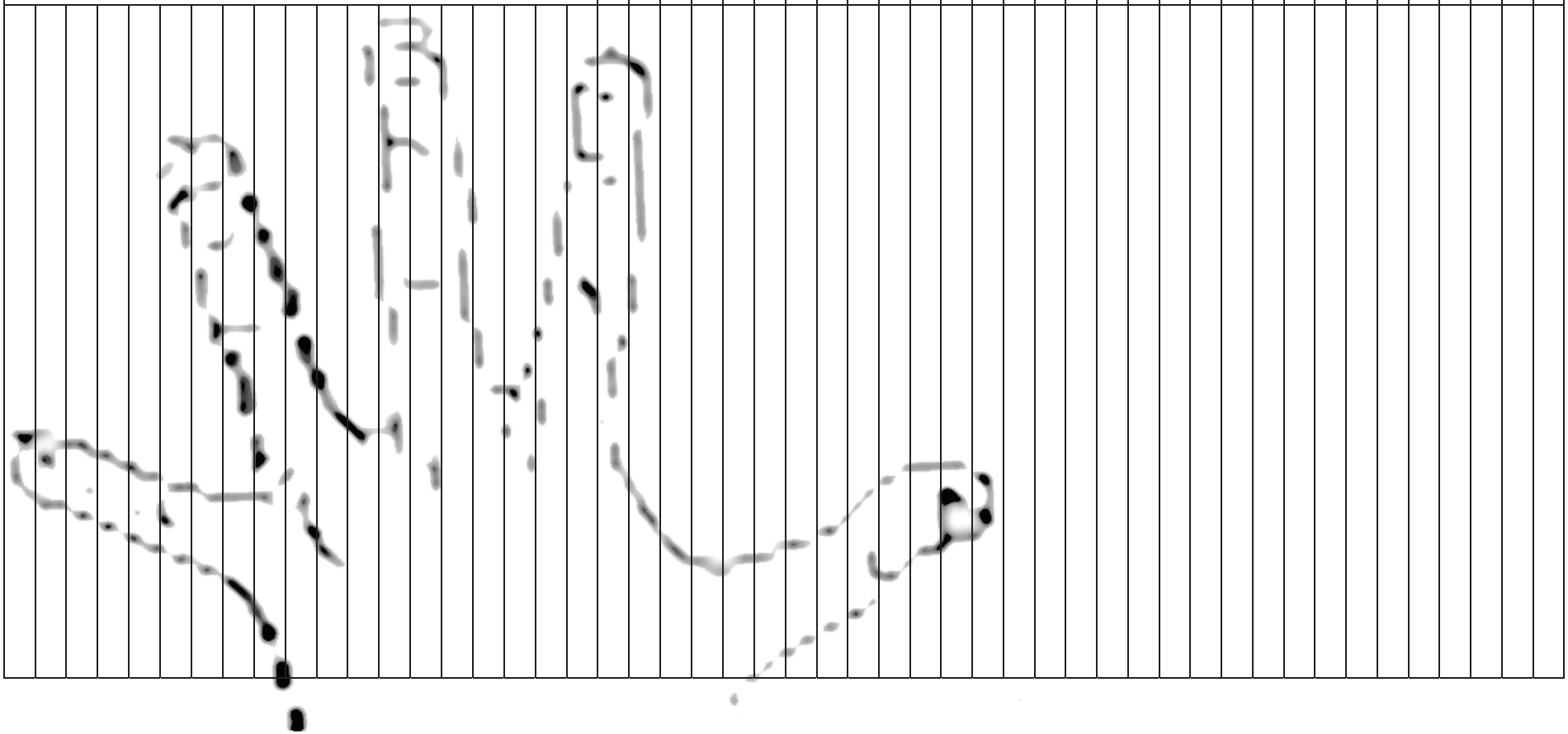
Ruler-table. Optimal grip span for **children** (6-12 years) according to hand size. The grip span is calculated from the equation by España-Romero et al. (J Hand Surgery [Am], 2008 Mar;33(3):378-84.): y = x/4 +0.44 for boys and y = 0.3x -0.52 for girls, where x is the hand size, and y is the grip span.

GRIP SPAN (cm) for FEMALES (Mark it with a circle)	3.5	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.7	4.9	5.0	5.2	5.3	5.5	5.6	5.8	5.9	6.1	6.2	6.4	6.5	6.7	6.8	7	7.1
GRIP SPAN (cm) for MALES (Mark it with a circle)	3.8	3.9	4.1	4.2	4.3	4.4	4.6	4.7	4.8	5.0	5.1	5.2	5.3	5.4	5.6	5.7	5.8	5.9	6.1	6.2	6.3	6.4	6.6	6.7	6.8
HAND SIZE (real cm)	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23	23.5	24	24.5	25	25.5



Ruler-table. Optimal grip span for **adolescents** (13-18 years) according to hand size. The grip span is calculated from the equation by Ruiz et al. (J Hand Surg, [Am]. 2006 Oct;31(8):1367-72): y = x/7.2 +3.1 for males and y = x/4 +1.1 for females, where x is the hand size, and y is the grip span.

GRIP SPAN (cm) for FEMALES (Mark it with a circle)	36	37	39	40	41	42	44	45	46	47	49	50	51	52	54	55	56	57	59	60	61	62	64	65	66	67	69	70	71	72	74
GRIP SPAN (cm) for MALES (Mark it with a circle)	45	46	46	47	48	48	49	50	50	51	52	53	53	54	55	55	56	57	57	58	59	59	60	61	62	62	63	64	64	65	66
HAND SIZE (real cm)	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23	23.5	24	24.5	25



5.3.2. Standing long jump

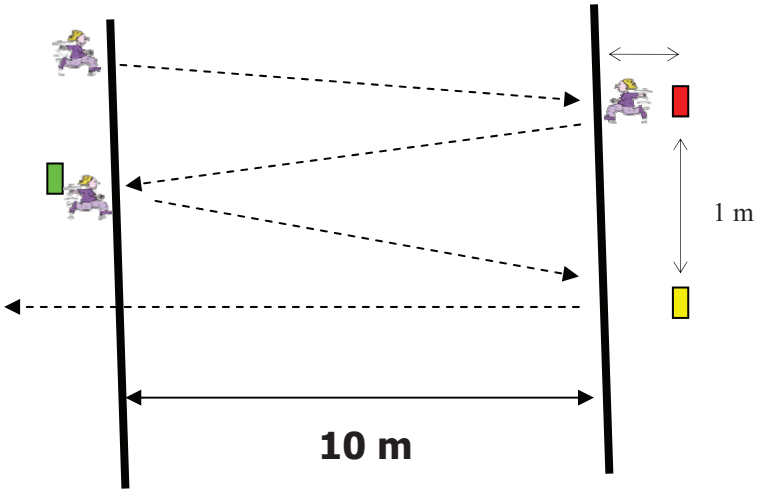
Purpose	To measure lower body explosive strength.
Health relation	Musculoskeletal fitness is inversely associated with established and emerging cardiovascular disease risk factors, back pain and with bone mineral content and density. Musculoskeletal improvements from childhood to adolescence are negatively associated with changes in overall adiposity.
Equipment	Non-slippery hard surface, stick, tape measure, adhesive tape, and cones.
Performance	Jumping for distance from a standing start and with feet together. **Instructions:** "Stand with your feet at the shoulder's width, and toes just behind the line. Bend your knees with your arms in front of you, parallel to the ground. As you swing both arms, push off vigorously and jump as far as possible. Try to land with your feet together and to stay upright. The test is done twice and the best attempt is recorded." **Practice and number of test trials:** The tester shows the right performance. Two trials are carried out and the best result is scored.
Measurement	Horizontal lines are drawn on the landing region 10 cm apart, parallel to and starting 1 m from the take-off line. A tape measure perpendicular to these lines gives accurate measurements. Stand on one side and record the distances jumped. The distance is measured from the take-off line to the point where the back of the heel nearest to the take-off line lands on the ground. A further attempt is allowed if the child falls backwards or touches the mat with another part of the body.
Scoring	The result is given in cm. *Example:* a jump of 1 m 56 cm scores 156.

5.4. Motor fitness

5.4.1. 4x10m shuttle run test

Purpose	To measure speed of movement, agility and coordination.
Health relation	Improvements in speed/agility seem to have a positive effect on skeletal health.
Equipment	Clean, non-slippery floor. Stopwatch, adhesive tape, tape measure, three sponges of different colours and four cones.
Performance	A running and turning (shuttle) test at maximum speed (4x10 m). Two parallel lines are drawn on the floor (with tape) 10 m apart. In the start line there is one sponge (B) and in the opposite line there are two sponges (A,C). When the start is given, the child (without sponge) runs as fast as possible to the other line and returns to the starting line with the sponge (A), crossing both lines with both feet. The sponge (A) is changed by the sponge B in starting line. Then go back running as fast as possible to the opposite line and change the sponge B by the C one and run back to the starting line (see figure, next page). **Instructions:** "Get ready behind the line. One foot should be just behind the line. When the start is given, run as fast as possible to the other line without sponge and return to the starting line with the sponge A, crossing both lines with both feet. Thereafter, change the sponge A by sponge B and go back running as fast as possible to the opposite line, where the sponge B must be changed by the C one. Finally, run back to the starting line without getting down speed before crossing it. Do the test twice: the best result is the score." **Practice and number of test trials:** The tester shows the right performance. Two trials are performed and the best time scored.
Measurement	Make sure that both feet cross the line each time, that he/she remains in the required path and that the turns are made as quickly as possible. Call out the number of cycles completed after each one. The test stops when the child crosses the finishing line with one foot. The child should not slip or slide during the test, so a slip-proof floor is necessary.
Scoring	The result is scored in seconds with one decimal. *Example:* a time of 21.6 sec is expressed as 21.6.

Graphic description.



Sponge A

Sponge B

Sponge C

5.5. Cardiorespiratory fitness

5.5.1. 20m shuttle run test

Purpose	To assess cardiorespiratory fitness.
Health relation	High cardiorespiratory fitness during childhood and adolescence is strongly associated with a healthier current and future cardiovascular health.
Equipment	A gymnasium or space large enough to mark out a 20m track, four cones, tape measure, CD-player and a pre-recorded CD of the test protocol.
Performance	Children are required to run between 2 lines 20m apart in time with an audio signal. The initial speed of the signal is 8.5 km/h and is increased by 0.5 km/h/min (1 minute equal to 1 step). The test finishes when the child fails to reach the end lines concurrent with the audio signals on 2 consecutive occasions. Otherwise, the test ends when the child stops because of fatigue. This test is done once. **Instructions:** "The shuttle run test gives an indication of your maximal aerobic capacity, i.e. the endurance, and involves running there and back along a 20m track. Speed will be controlled by means of a tape emitting buzzing sounds at regular intervals. Pace yourselves so as to be at one end of the 20m track or the other when you hear a sound. Accuracy to within one or two metres is enough. Touch the line at the end of the track with your foot, turn sharply and run in the opposite direction. At first, the speed is low but it will increase slowly and steadily every minute. Your aim in the test is to follow the set rhythm for as long as you can. You should therefore stop when you can no longer keep up with the set rhythm or feel unable to complete the one minute period. Remember the number announced by the recording when you stop, that is your score. The length of the test varies according to the individual: the fitter you are, the longer the test lasts. To sum up, the test is maximal and progressive, in other words easy at the beginning and hard towards the end. Good Luck!" **Practice and number of test trials:** Only one trial is performed.
Measurement	Select test site, preferably in a 25 m long gym. Allow for a space of at least one metre at either end of the track. The wider the area used, the more the number of children that can be tested simultaneously: one metre between each child is recommended. The surface should be uniform but the material of which it is made is not specifically important. The two ends of the 20m track should be clearly marked. Check the functioning of the sound track and CD player. Ensure that the device is powerful enough for group testing. Listen to the contents of the sound track. Note the numbers on the CD player timer so as to be able to locate the key sections of the track quickly.
Scoring	After the child has stopped, the last completed half-step is retained. *Example:* a score of 6.5 stages. If a higher precision is required (eg. intervention studies aiming to detect small changes), the final time spent in the test expressed in seconds, instead of half stages, can be retained.