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## Physical fitness and sport activity of children and adolescents: Methodological aspects of a regional survey

### Summary

Measurement of physical fitness and physical activity in children and adolescents raise a lot of methodological issues, explaining the scarcity of surveys in European countries and in Switzerland. This article exposes the design and the methods used in a survey on physical fitness, physical activity and health conducted in a region of Switzerland, and discuss the choice of the instruments and the quality control procedure selected to measure physical activity and physical fitness. The survey was conducted in a sample of 3540 students 9–19 years-old and included a battery of physical fitness tests, anthropometrics measurements and a self-report questionnaire on physical activity, sports activity and life styles. An ancillary study in a sub sample assessed daily physical activity with a pedometer, dietary intake with a 3-day dietary record, serum lipids and nutritional status. Some results are displayed as example. Quality control techniques are exposed and the choice of the instrument to assess physical fitness, physical activity, sports, and dietary intake are discussed. Local reference tables are now available for fitness tests and the practicability of fitness testing has been demonstrated in physical education. The research process has induced the sensitisation of schools toward health promotion through physical activity.

Substantial evidence on the relationship between physical fitness, physical activity and physical and psychosocial health have been reported recently in adults and, less frequently, in adolescents<sup>1,2,3,4</sup>. The findings demonstrate the burden of sedentary living habits to health and the benefit of regular, and moderate physical activity for adolescents<sup>5</sup>. Physical activity seems to be a part of children daily

activity, but when growing older many adolescents in industrialized countries gradually become inactive<sup>6,7,8,9</sup>. This disruption may fail to carry over the daily physical activity habits from childhood to adulthood. During adolescence, considerable change in lifestyle, and the individual evolution in growth and development are often considered to have consequences on physical abilities<sup>1,6,10</sup>. The im-

part of physical activity during younger age on health outcomes in adulthood is still debated, but it is generally believed that active youths become active adults<sup>11</sup>. Some longitudinal studies conclude that physical activity declines sharply during the early years of adulthood, partly because of secular trends, and that physical inactivity shows better tracking than does physical activity<sup>12,13</sup>.

Therefore, health promotion programs should encourage physical activity in children and adolescents through the school and community programs<sup>14,15</sup>. In general, no clear effects of intensive health-related school physical education upon the physical and psychological development of adolescents could be proved, even if some recent studies have shown an improvement of children's level of physical activity and a decrease of their cardiovascular risk factors<sup>6,16</sup>. However, speaking of physical activity or inactivity, there is a need to distinguish between sports activities, competitive or recreational, and habitual physical activities.

To be able to develop health promotion programs for adolescents, it is necessary to assess both physical fitness and physical activity patterns, as well as hypertension, obesity or lifestyle variables like

smoking<sup>2,4,17</sup>. Some large population studies in Europe have measured physical fitness, physical activity and health behaviours, sometimes with longitudinal device<sup>6,18,19</sup>. But very few of them included children and young adolescents, and they have been confronted to the lack of a valid reference method to assess physical fitness and physical activity.

The measurement of both physical fitness and physical activity in children and adolescents has long been a topic of interest to physical educator and public health scientists, but raises some controversial questions due to conceptual definitions and methodological issues.

Many versions of a definition of *physical fitness* have been published, but most of the times this construct is recognized as a multifaceted ability which has to be measured through various component as cardiorespiratory endurance, strength, muscular endurance, speed, flexibility or balance, and body composition<sup>17,20,21</sup>.

Various fitness test batteries are used to assess physical fitness, especially in the United States, but few of them have criterion reference standards, table of norms and validity evidence<sup>22</sup>. Moreover, the fitness tests may be useful to develop norm-referenced standards at a national level, to be able to use them for student motivation and learning purposes<sup>23</sup>. The Eurofit tests battery has been developed and used to assess physical fitness among children and adolescents in different European countries<sup>21,24</sup>. The Eurofit battery originally includes nine tests<sup>25</sup>. To shorten the session, and to improve the cooperation and motivation of the participants, three of the tests were discarded, that is the hand grip, the bent arm and the Flamingo test, because they were not included in other batteries used in USA, and didn't add much information or because they are poorly reliable (Van Mechelen, personal commu-

nication). These tests are aimed at measuring abilities such as strength, flexibility and endurance rather than measuring skills, as stated by Kemper and Van Mechelen<sup>23</sup>. In the most recent published batteries the health related aspects of physical fitness are predominant, giving a large place to cardiovascular function and including body composition measurement, i.e. "Fit youth today" or "AAHPERD: American Alliance for Health, Physical education, Recreation and Dance"<sup>22,26</sup>. The *anthropometric measurements*, as a part of fitness definition or as an evaluation of body build and body composition of the participants include *skinfold thickness* and *height and weight* (gross estimations of growth and physical development).

*Physical activity* has been defined as "any bodily movement produced by skeletal muscles that results in energy expenditure"<sup>27</sup>. Over a 24h period, the aerobic process delivers approximately 98% of all the energy, and the assessment of habitual physical activity is possible by measurement of all daily activities or/and by an estimate of the kind, duration and frequency of the more intensive forms of physical activity<sup>28</sup>.

The objective measurement of physical activity is possible in field study by the use of portable device (a heart rate integrator or a pedometer). In large group studies, the use of self report through an interview or a questionnaire is applicable, simple, cheap and time efficient<sup>29</sup>, but we haven't found any validated instrument in the French language to assess sports activity, organized or recreational, and every day life activity of children and adolescent, even if such instruments are available for adults.

Other measurements are useful to explore the relationship between physical fitness, physical activity and health: pubertal development may be assessed by the *Tanner stages* of development and age of

the menarche, for girls; *blood pressure*, *blood lipid profile* and *dietary intake* are sometimes added in the evaluation of health. Finally, variables of *lifestyle* as smoking habits or sedentary leisure time activities are often included in the questionnaire. All these measurements need to be performed in standardized conditions by trained professional; because of the organisational burden, they are rarely performed within the same study. For instance, the Bogalusa and Muscatine studies have focused on diet, blood pressure, blood lipoproteins level and lifestyle (physical activity included) without fitness assessment in a longitudinal process, from childhood to adulthood<sup>30,31</sup>. In the European countries, such comprehensive study have seldom been conducted among children and adolescents<sup>28</sup>.

This article presents the design and first results of a survey conducted in a region of Switzerland in 1996–1997 on physical fitness, physical activity and health related factors in children and adolescents between 9 and 19 years of age. The objectives of the survey were: 1) to use a fitness tests battery derived from the Eurofit battery; 2) to measure physical fitness of children and adolescents and to produce reference measurements by sex and age; 3) to assess physical activity of these children and adolescents and analyse the relationship between physical fitness, physical activity and health. Moreover the survey included an ancillary study among a sub-sample, with the objectives to measure: 1) physical activity with a pedometer; 2) nutritional intake with a three days diary; 3) blood lipid profile, to explore relationship between physical activity and other risk factors for coronary heart disease among adolescents.

This paper focuses on the methods of the survey. Some methodological issues are discussed with regard to the choice of the instruments, the organisation, the feasibility and

the quality of the measurement, with a special emphasis on physical fitness and physical activity assessment. The detailed results of the survey will be published and discussed elsewhere.

**Methods**

Sampling and procedure

The survey on physical fitness and sport activity of children and adolescents was conducted from September 1996 to March 1997 in the schools of the canton of Vaud, a part of the french speaking region in south western Switzerland. A two-step cluster sampling procedure was used to select classes from the 4<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> grades (9–19 year old pupils). Sampling stratification was performed by region and school curriculum: schools were selected in groups of schools classified in three types of region, based on the geographic density of the population. The same number of classes were selected from a unique group of 4<sup>th</sup> grade, from the three main curricula in the 6<sup>th</sup> and in the 8<sup>th</sup> grades and from high schools and apprentice schools separately, in the 10<sup>th</sup> and in the 11<sup>th</sup> grades.

The *main survey* consisted in physical fitness testing, anthropometrics measurements and a questionnaire on physical activity, sports and lifestyle. The physical fitness and the anthropometrics testing were organised during an ordinary session of sport and physical education, in the morning. Students completed the questionnaires during a regular period, in the afternoon of the same school day. Passive consent was obtained from the parents by sending a letter one week prior to the data-collection visit at school. In addition to parental consent, children and adolescents received an information at school to encourage their participation and obtain their consent at the time of data collection. A procedure was used to assure anonymity of all the data collected. The protocol was reviewed by the Ethic Committee of the Medical School, University of Lausanne.

The *ancillary study* included three measurements (physical activity assessed with a pedometer during one week, three days dietary intake diary and blood testing) performed on a sub-sample of 248 participants randomly selected among the 4<sup>th</sup> and 6<sup>th</sup> graders. The data collection was organised in each school during the week before the day of

the main data collection, with two appointments on the first and the 8th day at school (Figure 1). Active consent was obtained from the participants and from their parents by sending a letter and through telephone.

**Measures and instruments**

Measures and instruments of the main survey

*Physical fitness* was assessed by a set of six tests derived from Eurofit<sup>21,23,24</sup>. They are aimed at measuring abilities such as strength, flexibility and endurance rather than measuring skills<sup>23</sup>. These tests have been widely used in sport education or research conditions and each one has been validated at a minimum by a test-retest procedure. The table of norm-referenced standards have been published for them in several European countries. They are compatible with some other sets of tests used in the USA and Canada, and with the Swissfit set proposed by the Federal School for Sports (EFS, Macolin, Switzerland)<sup>21</sup>. The following tests were included:

- Sit-and-reach test (flexibility)
- 5 m × 10 run (speed)

<i>Ancillary study on a sub-sample of 248 participants</i>			<i>Main survey</i>
<i>material and instructions for:</i> – pedometer – activity diary – dietary intake diary	<i>7 days pedometer recording</i> <i>3 days dietary intakes recording</i>	<i>blood sampling</i>	<i>fitness tests</i>
		<i>debriefing for:</i> – pedometer – activity diary – dietary intake diary	<i>anthropometric measurements</i>
			<i>questionnaire</i>
<i>n = 248</i>			<i>N = 3754</i>
<i>1<sup>st</sup> day</i>	<i>1<sup>st</sup> to 8<sup>th</sup> days</i>	<i>8<sup>th</sup> day</i>	

**Figure 1.** Design and timetable of the ancillary study and main survey.

- Sit-up test (muscular endurance)
- 50 plate tapping (speed)
- Standing long jump (strength)
- 20 m shuttle run test (cardiorespiratory endurance).

The endurance shuttle run test, originally designed by Léger et al.<sup>32,33</sup>, is known to be correlated with  $\text{VO}_2\text{max}$  and thus allows a good assessment of aerobic capacity. The sit-up test has good reliability<sup>34,35</sup> and adequately reflects the muscular power of trunk muscles. The standing broad jump (without run up) assesses the muscular power of inferior limbs and has also good reliability ( $r > 0.90$ )<sup>35</sup>. The sit and reach tests, which assesses flexibility, is widely used in different batteries and has an acceptable reliability ( $60 < r < 70$ )<sup>35</sup>. All these tests were performed after warm-up, demonstration and explanation in the usual sports room. Each test procedure was standardized and carried out under the supervision of a trained research assistant.

*Body composition*, considered as a part of the fitness measurement, was assessed by measuring skinfold thicknesses in 4 sites: bicipital, tricipital, scapular and suprailiac<sup>36</sup>. Weight, height, self evaluation of puberty and blood pressure were recorded. Weight was measured with a beam balance to the nearest 0.1 Kg. Height was measured with a portable stadiometer Harpenden®  $\pm 0.1$  cm.

A self-assessment of *puberty* used drawings illustrating the five Tanner stages<sup>37</sup>. *Blood pressure* was measured with a usual sphygmomanometer (Erkameter 3000. Erka®), as described in the MONICA study<sup>38</sup>. Three sizes of the cuff were adapted to the size of the arm, as previously recommended<sup>39</sup>.

All the measurements were made by trained school nurses in a separate room, on the day of the main study, as part of the general survey. *Reported physical activity and lifestyles* were measured using a self-

administered questionnaire. Physical activity of the subject was assessed through the average daily time spent in exercise inducing sweating, indicator used in the MONICA survey<sup>38</sup>. Questions on sport physical activity used a 37-item check-list (recall of the last week activity), a weekly frequency assessment of organized sport activities (in club or team) and of non-organized sport activities for the last 12 months. Because the choice has to be in accordance with the practices of the adolescents in Switzerland, the three lists of sports were developed with physical education teachers and athletic adolescents from clubs. The check lists were pre-tested with an additional open question to be able to complete the lists. Leisure time activity (i.e. watching television) and habitual physical activity (i.e. transportation used to go to school) were also included.

A 36-item questionnaire assessed food frequency intake (never, once-twice a month, 1–3 times a week, 4–6 times a week, once a day, 2 or more times a day). Additional questions estimated meal pattern and snacks consumption. These questions have been developed in collaboration with the Nestlé Research Center<sup>40</sup>.

The last part of the questionnaire assessed substance use, some health-related perceptions and needs, and socio-demographic status.

Most of the questions were taken from other surveys instruments. Three versions of the questionnaire were developed to be acceptable by the 3 age groups (9–12, 13–15, 16–19 year old teenagers), and pre-tested. The questionnaire was confidential and self administered in the classroom setting under the supervision of the research assistant.

Measures and instruments of the ancillary study in a subgroup

An objective measurement of *daily physical activity* was performed in a

subsample by the use of an actometer/pedometer. The participants were asked to wear a Pedoboy® (Barrigo GmbH, Schweningen, Germany) during seven days and to fill out a 24 hour diary of their activities. The Pedoboy is a small resistant and inexpensive instrument which records the vertical acceleration produced by the body's centre of gravitation. The cumulative values displayed by the cursor on the dial are recorded daily and at the end of the week. The Pedoboy® was sealed with tape to avoid manipulations. All the subjects were advised to keep wearing their instrument all day long especially during periods of physical activity and to remove it only during some sports such as judo or swimming.

To assess nutrient intake, a *three-day dietary record* was used during the week of the pedometer testing<sup>41,42</sup>. The dietician gave a phone call to the mother during the week of the record and had an interview with the child and the mother at the end of the week to review the diary in order to improve quality of the data collected. Nutritional data were mainly expressed in terms of energy and macro-micronutrients intake. This part of the study was carried out by the Nestlé Research Center (CRN).

Different *biochemical measurements* were performed to assess some of the risk factors for coronary heart disease (total cholesterol; HDL and LDL cholesterol; triglycerides) and the nutritional status including iron status (hemoglobin, hematocrit; iron; total iron binding capacity; transferrin, ferritin, folate, vit. B12), trace-elements (growth, immunity, antioxidant effect: copper, zinc;  $\beta$ -carotene; vit. A, vit. E) and proteins and acute phase reactants (Albumin, prealbumin;  $\alpha 1$  acidglycoprotein; C-reactive protein).

Blood samples were aliquoted and stored at  $-80^\circ\text{C}$ . All measurements were made at the end of the study in the same lab.

## Results

Among the 30'754 students in the reference population (total population in the region is around 600'000 inhabitants), 3'754 students were selected and 3.8% were absent or refused to participate. Data were analysed from 3'540 children and adolescents 9–19 years old, representing those with completed questionnaire. –1.9% older than 19 years were excluded (Table 1). Among them, 4% did not participate in fitness testing and anthropometric measurements because they were absent for the morning or because they were exempted from sport classes.

Some examples of the first results illustrate the practicability and advantage of the design of this survey. The fitness test battery has proved its practicality in school-based physical education and norm-referenced scales were established, based on percentiles scores. Only 5% of the fitness results were missing among the 9–14 year old participants and 8% among the 15–19 year old. Boys had better performance than girls for endurance and strength tests, but girls had better performances for flexibility test. Among boys the performances were improving with age for all tests except for sit-ups. But among girls, the improvement of performance seemed to slow down after menarcheal age. Means and 95% confidence intervals of the sit-and-reach tests are displayed as examples (results for boys and girls) in Table 2.

Twelve percent of the 13–19 years old boys and 18.3% of the girls claimed not to take part in any sport activity, while 94% of the 9–12 years old declared having practised one or more sport sessions during the precedent week. Boys were more often involved in a sport activity than girls and there was a decrease of sport activity frequency with age. The mean of the number of periods of sport

Age/years	Gender		Total
	Female	Male	
9	131 7.4%	98 5.6%	229 6.5%
10	228 12.8%	217 12.3%	445 12.6%
11	154 8.7%	139 7.9%	293 8.3%
12	223 12.5%	219 12.4%	442 12.5%
13	133 7.5%	119 6.8%	252 7.1%
14	229 12.9%	211 12.0%	440 12.4%
15	169 9.5%	158 9.0%	327 9.2%
16	212 11.9%	203 11.2%	410 11.6%
17	153 8.6%	203 11.5%	356 10.1%
18	107 6.0%	137 7.8%	244 6.9%
19	39 2.2%	63 3.6%	102 2.9%
Total	1778 100.0%	176 100.0%	3540 100.0%

**Table 1.** Sample by gender and age.

activity performed by boys during the last week, without reference to the duration of each period, increased from 5.87 (95% confidence interval: 5.22–6.52) to 7.34 (6.76–7.92) between 9 and 12 years of age, and decreased from 7.81 (7.10–8.52) to 4.11 (3.33–4.89) between 13 and 19 years of age. Cycling, walking and football were the most widely quoted sport activities among 37 items.

Twenty two percent of girls and 14.2% of boys declared less than 30 minutes of physical activity

inducing sweating per day. This percentage was twice as high among the post-secondary students – 16–19 years old – (31.9% of girls and 20.1% of boys) than among the younger children – 9–12 years old – (16.8% of girls and 10.5% of boys).

As an example of anthropometric measurement, BMI (body mass index) was calculated and is described on Table 3. The increase in mean BMI with age shows a pattern similar to the curves from the first Zurich longitudinal study of

Age	Girls			Boys			Total		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
9	153	21.01	4.09	123	22.89	3.92	276	21.85	4.11
10	194	21.59	4.16	179	23.02	3.96	373	22.27	4.12
11	175	22.85	4.24	164	25.5	4.11	339	24.13	4.38
12	197	23.71	3.66	178	25.7	3.54	375	24.65	3.74
13	148	24.59	4.08	135	26.91	4.39	283	25.7	4.38
14	189	24.66	4.12	198	27.67	4.51	387	26.2	4.57
15	159	23.32	4.65	137	27.89	4.86	296	25.44	5.26
16	184	23.67	4.21	177	28.73	4.64	361	26.15	5.09
17	142	24.18	4.32	190	30.1	5.03	332	27.57	5.57
18	91	23.25	4.38	116	28.43	5.92	207	26.15	5.88
19	32	25.53	4.68	53	29.7	5.68	85	28.13	5.67
<b>Total</b>	1664	23.32	4.34	1650	26.85	5.07	3314	25.08	5.04

**Table 2.** Sit-and-reach test: mean by sex and age and 95% confidence interval.

Age	Girls			Boys			Total		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
9	153	17.43	2.37	123	17.39	2.34	277	17.41	2.35
10	194	17.67	3.03	178	17.52	2.43	372	17.60	2.76
11	176	18.44	3.06	164	18.22	2.59	340	18.33	2.84
12	196	18.95	3.01	180	18.73	3.03	376	18.85	3.019
13	148	19.44	2.60	136	19.22	3.16	284	19.33	2.88
14	189	20.59	3.30	200	20.13	3.04	389	20.35	3.17
15	163	20.71	2.51	141	20.47	3.26	304	20.60	2.88
16	193	21.43	2.71	178	21.02	2.75	371	21.23	2.73
17	145	21.67	3.01	190	21.53	2.65	336	21.59	2.80
18	90	21.70	2.79	118	21.44	2.92	208	21.55	2.86
19	33	22.29	3.30	53	22.18	2.80	89	22.21	2.97
<b>Total</b>	1680	19.74	3.26	1661	19.68	3.20	3346	19.71	3.23

**Table 3.** BMI (Body Mass Index) by sex and age. Mean and 95% confidence interval.

growth and development<sup>45</sup>. The fact that the 50th percentile curve seems above the reference values measured in that cohort study 10 years ago could be attributed to the secular-trend effect.

Table 4 shows, as example, some Pearson correlation coefficients measured in the subgroup: be-

tween VO<sub>2</sub>max estimated through 20 m shuttle run test and physical activity measured by pedometer, physical activity and sport activity estimated by questionnaire and BMI. Correlation coefficients between physical activity measured by questionnaire and physical activity measured by pedometer, and

between physical activity and sport activity are also exhibited here.

## Discussion

Limits and bias of the data collection

Sampling bias could be derived from the school sampling method,

	Weekly physical activity (pedometer)	Weekly sport activity in club	BMI	Daily physical activity (Monica)
VO <sub>2</sub> max	0.307	0.364	0.290	0.170
Cardiorespiratory endurance	p = 0.000 (n = 212)	p = 0.000 (n = 118)	p = 0.000 (n = 223)	p = 0.011 (n = 220)
Daily physical activity (Monica)	0.215	0.548	0.068	
	p = 0.001 (n = 223)	p = 0.000 (n = 125)	p = 0.316 (n = 221)	

**Table 4.** Pearson correlation coefficients between some outcome variables.

excluding drop-out and absent youths especially in post-mandatory schools. Among the participants between 9 and 19 years of age who had filled in a questionnaire, 4% of the sample didn't participate in fitness and anthropometric testing. Refusal and non-participation in this part of the survey were more frequent in the older group of students; this could be explained by the organisation of secondary school and apprenticeship centres where physical education classes are less important and are not included in final examination. Moreover, in this survey, more teenagers than children are excused from or simply fail to attend physical education courses. The missing values for the different measurements and questions are less than 2% among those who have participated in all the testing.

As usually recommended in fitness study, typical quality control techniques (i.e. quality control of the material, the operators and the measurement itself) were used to collect the data in order to be confident that each participant was measured consistently and accurately<sup>44,45</sup>. The measurement protocols were developed and adapted after pilot testing which ensured feasibility and time constraints management. They provided guidelines to perform the tests on the same installations and with movements including the same gestures. A senior research assistant was in

charge of field quality control: the control of the administration of the testing protocol and the monitoring of calibration of test equipment. For the fitness tests and the anthropometric measurement, the number of operators was limited to avoid interobserver differences: a principal operator with only one supply operator for one test, equally assigned to the different age groups to avoid systematic errors. This bias is low for fitness tests or height and weight, but could be high for skinfold thickness or blood pressure<sup>46,47</sup>. The skinfold thickness were measured by the same nurse, but, for organisational reasons, the blood pressure was measured by trained school nurses.

#### Choice of the instruments and organization

Measurement protocols have been established for anthropometric, blood pressure, and serum lipids measurement after an expert consultation and a discussion of scientific validity, and practical consideration about the different instruments and available techniques<sup>47</sup>.

Among the examples given in Table 4, cardiorespiratory endurance test is correlated with pedometer measurement, weekly sport activity in club and BMI, but less with daily physical activity estimated through the MONICA survey indicator. The most important cor-

relation is between weekly sport activity in club and daily physical activity measured through the MONICA survey indicator, showing a sense of coherence because intensity of activity is included in these two questions. The results of the different tests are similar to the results of Eurofit survey in different European countries<sup>48,49</sup>. The results and comparisons are exposed elsewhere<sup>50</sup> and won't be discussed in detail in this paper.

The discussion will focus on three important methodological issues: fitness tests, physical activity and nutrition assessment.

#### Physical fitness tests

The review of physical fitness measurement shows that there is a lack of scientific evidence to choose a fitness test battery<sup>20,22</sup>. Test-retest reliability coefficients of some US test batteries as well as individual subtests vary greatly and higher reliability coefficients have been observed in older than in younger children<sup>51</sup>. An operational definition of physical fitness helped us to choose six tests pertaining to its dimensions. The tests were selected from the Eurofit battery because most of them have proved to be reliable and discriminant in children and adolescents, and norm-referenced standards are existing for children and adolescents from different European countries<sup>23,51</sup>. For example, bent arm hang was

excluded because less discriminant (Van Mechelen personal communication).

The results of the fitness testing are influenced by the control of the administration of the testing protocol, but also by the motivation of the participant to get the best performance. The research assistant in charge of field quality control displayed information on the objectives of the survey and played an important role in the encouragement of the participant during the testing. The involvement of the physical education teachers may have had a positive impact on the quality of the results.

#### Physical activity and sports activities assessment

The variety of methods to assess physical and sport activities is great, but in a large-scale population design, only recall by questionnaire is currently applied<sup>2-54</sup>. Several questionnaires are available for assessing habitual physical activity, but few of them have been validated, especially in French language, and among children and adolescents. The questions were selected from existing instruments: precise time period and short-term recall were preferred to general question or usual frequency assessment, in order to improve the accuracy of the report<sup>2-54</sup>. For example, the respondent were asked to display which sport, out of 37 items, they had practised on each of the seven last days.

The evaluation of physical activity implies the establishment of an exercise intensity level which confers health benefits, and we have used data reported in terms of individual perceived exertion as sweating and breathlessness. This variable seems relatively accurate in terms of stress on the body, but does not allow an estimation of energy expenditure because it does not take into account of individual level of fitness<sup>55</sup>. The different

dimensions of physical education, leisure time activities, organised and non organised sport activities and parents physical activity were assessed in the questionnaire, and supply a more comprehensive information.

The use of a pedometer in a subsample gives another assessment of physical activity among the younger participants. Although the validity and reliability of this device among children have not been demonstrated convincingly in children, the pedometer has apparent benefit<sup>52</sup>. It avoids problems with recall and subjectivity, its cost is low and it can be used for long-term monitoring, and it has proven its practicability in this small group of teenagers<sup>52</sup>.

#### Dietary intake

The food frequency questionnaire had been developed previously and validated in a group of 20 adolescents from the region, using a modified version of the diet history method (3-day dietary record and interview)<sup>40</sup>. Food frequencies do not provide precise estimate of absolute nutrient intake, but classify subjects on the basis of their ranking relative to others<sup>47,56,57,58</sup>. In the older group (15–19 years old) portion sizes were used in order to compare data collected with USDA recommendation<sup>59</sup>.

The ancillary study used a three-day dietary record which was given to the children of the subsample and explained to the mother. The quality of the data collected was excellent (only 2 diaries among 248 were excluded for inadequate reporting). The personal contact of the dietician with the mothers by phone just before and, when necessary, at the end of the study and the interview with each teenager contributed to this quality.

## Conclusion

The organisation of the survey including the different measurements and the survey by questionnaire was a rather demanding process. Both the general design and the procedures of the ancillary study have proven their practicability. Such methodology could be used to conduct the survey in another region of the country in order to develop physical activity and health monitoring in children and adolescents.

The measurements, especially the fitness testing, have proven their feasibility in the school environment. The fitness test battery has been used in physical education setting, showing that fitness testing could be introduced during the physical education classes. The teachers have experienced the demonstration of what they could do with the test battery, and it will be easier for them to use the reference table now available. Criterion reference standard table were established and are available for physical education teaching.

The collaboration with school authorities and with teachers has been a good incentive to their awareness to health promotion outcomes of physical exercise. It can be important to put positive objectives like physical activity development in the health education agenda.

The comparison of result across regions or countries will help to elucidate the relationship between environment, behavioural characteristics and risk factors of cardiovascular diseases in adolescent population through the "French speaking network in health promotion and heart disease prevention for children and adolescent" (5 French speaking regions in France, Belgium, Canada, Tunisia and Switzerland), chapter of the REFIPS (International French speaking Network for Health Promotion).

## Zusammenfassung

### Physische Kondition und sportliche Aktivität von Kindern und Jugendlichen: Methodologische Aspekte einer regionalen Umfrage

Das Messen der physischen Kondition und der physischen Aktivität von Kindern und Adoleszenten wirft eine Vielzahl methodologischer Fragen auf, weshalb wohl in europäischen Ländern und in der Schweiz bisher nur wenige solche Untersuchungen durchgeführt wurden. Es sollen in dieser Studie, welche in einer Region der Schweiz zum Thema physische Kondition, körperliche Betätigung und Gesundheit durchgeführt wurde, die zur Anwendung gekommenen Untersuchungsmethoden dargestellt und das eigentliche Vorgehen beschrieben werden. Ebenfalls werden die Instrumentenwahl sowie die für diese Studie ausgearbeiteten Verfahren zur Qualitätssicherung der Messungen der physischen Kondition und der physischen Aktivität diskutiert. Die Untersuchung wurde mit einer Auswahl von 3540 neun- bis neunzehnjährigen Schülern durchgeführt und beinhaltet die Messung der physischen Kondition mit Hilfe einer Testserie, anthropometrische Messungen und einen Fragebogen zur physischen Aktivität, sportlichen Betätigung und zum Lebensstil. Eine Zusatzstudie wurde in einem Teilkollektiv durchgeführt. Dabei wurden die tägliche physische Aktivität mit Hilfe eines Pedometers gemessen, während drei Tagen ein Tagebuch über die Nahrungsaufnahme geführt und die Lipidwerte im Blut sowie der Ernährungszustand analysiert. Einige Ergebnisse werden als Beispiel aufgeführt. Die zur Qualitätsgarantie der erfassten Daten eingesetzten Massnahmen, sowie die Wahl der für die Messungen der physischen Kondition, der körperlichen Aktivität, der sportlichen Betätigung und der Ernährung verwandten Instrumente werden diskutiert. Das Erstellen von lokalen Referenztabellen zur physischen Kondition von Jugendlichen erlaubte es, die Konditionstests in den Sportunterricht einzuführen und schulnahe Kreise dafür zu sensibilisieren, dass die körperliche Betätigung für eine Strategie der Gesundheitsförderung eine wichtige Rolle spielt.

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**Résumé****Condition physique et activité sportive des enfants et des adolescents: aspects méthodologiques d'une enquête régionale**

La mesure de la condition physique et de l'activité physique des enfants et des adolescents pose des problèmes méthodologiques particuliers, qui expliquent sans doute le petit nombre d'études de ce type dans les pays européens et en Suisse. Cet article présente la procédure et les méthodes utilisées dans une enquête sur la condition physique, l'activité physique et la santé, réalisée dans un canton de Suisse et discute le choix des instruments et des procédures mises en œuvre pour assurer la qualité des mesures de la condition physique et d'activité physique. L'enquête a été conduite dans un échantillon de 3'540 élèves de 9 à 19 ans et comprenait des mesures de la condition physique grâce à une batterie de tests, des mesures anthropométriques et un questionnaire sur l'activité physique, la pratique sportive et les habitudes de vie. Dans un sous-échantillon, on a utilisé un pedomètre mesurant l'activité physique quotidienne, un journal alimentaire de trois jours et un dosage sanguin des lipides et du status nutritionnel. Quelques résultats sont donnés à titre d'exemple. Les mesures mises en place pour assurer la qualité des données recueillies sont discutées, ainsi que le choix des instruments de mesure de la condition physique, de l'activité physique, de la pratique sportive et de l'alimentation. La réalisation de tables de référence locales pour les tests de condition physique a permis d'introduire l'utilisation des tests de condition physique dans l'enseignement de l'éducation physique, et de sensibiliser le milieu scolaire à l'importance de l'activité physique dans une stratégie de promotion de la santé.

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