The ACDSi 2014 – a decennial study on adolescents' somatic, motor, psycho-social development and healthy lifestyle: Study protocol

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Abstract

The Analysis of Children's Development in Slovenia (ACDSi) is a decennial study on children's and adolescents' somatic, motor, psychological and social development in Slovenia. In 2014, the study included 1,479 adolescents and young adults between 14 and 24 years of age. From its beginnings in 1970, it has been characterised as an interdisciplinary study of physical anthropology, kinesiology, psychology and sociology. In its third cycle on adolescents in 2014, the study was expanded to include public health issues. The aim of the study is to observe the secular trends of the somatic and motor development of adolescents in Slovenia regarding the psychological, social and health determinants that shape contemporary adolescents' lifestyles. This paper describes the protocol of the ACDSi 2014 study with regards to its organisation, sampling and methods.

KEYWORDS: adolescents, somatic development, motor development, physical fitness, health

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Background

The 2014 ACDSi study of adolescents is a continuation of the ACDSi study of children from 2013 (Jurak, Kovač & Starc 2013). The history of the ACDSi study with its beginning in 1970 has been previously described and published (ibid.) and the protocol of the study of adolescents is similar to the protocol used in the study of children.

Although the study included only a primary-school population from 11 to 14 years of age in 1970 and from 7 to 14 years of age in its second cycle in 1983/84, in its 1993/94 cycle[1] the sample was expanded to include adolescents (aged 15 to 18) from 16 secondary schools,[2] located in the central, eastern and western regions of Slovenia. Thereafter, a sample of every study cycle has included approximately 5,500 children and adolescents aged 7 to 18 years (around 2% of the entire school-age population) (Table 1).

Table 1: ACDSi sample in different study cycles

Study cycle	Principal investigators	Sample age span (years)	Sample size
1970	Šturm, J.	11–14	3,272
1983	Strel, J. & Šturm, J.	7–14	3,163
1993/94	Strel, J., Šturm, J. & Kovač, M.	7–14	3,488
		15–18	1,620
2003/04	Strel, J., Kovač, M., Starc, G., Jurak, G.	7–14	4,095
		15–18	1,694
2013/14	Starc, G., Jurak, G., Kovač, M.	6–14	3,478
		15–18*	1,479

** The secondary-school 2014 cycle also included 56 young adults aged 19 and 16 young adults aged 20 or more.*

Organization of the study

The organisation of the 2014 adolescent study was identical to the 2013 children study, described by Jurak et al. (2013). The research was not granted any specific funding, and the researchers and students did not receive any payment for our involvement in the study. The employers of the involved researchers allowed us to work on the research during our work time and receive our usual monthly salaries. The complete research team, including international advisors, is presented in Table 2. According to our agreement, all the participating researchers have the right to use the data with the consent of the project leaders who manage the database. The compiled database with all the measurements and premise description of protocols is accessible upon request and available to the international research community for comparison and analyses.

[1] Each study cycle from 1993/1994 onwards was carried out two consecutive years. In the first year, primary-school and in the second year secondary-school population was measured.

[2] The sample includes different secondary-school programmes: general (grammar), technical and vocational schools. In the 2014 cycle, one school was dropped from the sample in order to keep the proportions of sample regarding the school programmes similar to the national proportions. In the last 10 years, the number of students in vocational schools has dropped, and we adjusted the school sample accordingly.

Methods

Main objectives and areas of interest

The purpose of the 2014 study cycle was to establish the somatic and motor development of the contemporary generation of secondary school adolescents in Slovenia through specific research objectives: a) to explore contemporary adolescents' lifestyles and their predictors, b) to establish the levels of physical fitness and body composition of contemporary adolescents and set the national standards of somatic and motor development, and c) to quantify the secular changes in the physical fitness of Slovenian adolescents in the previous 20 years and to compare these changes to the available international data.

Table 2: The 2014 research team

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The main areas of interest of the study were, therefore: body composition, physical fitness, self-concept and motivation for physical activity, physical activity and sedentary behaviour, social and physical environment, sleep patterns, lifestyle and health.

The study was constructed to adhere to descriptive and predictive levels of adolescents' somatic and motor development. A list of more detailed descriptive research goals includes:

– socioeconomic environment of adolescents;

– somatic development of adolescents; national charts of growth, weight, BMI, hip-to-waist circumferences, different skinfolds, and body fat, developmental somatochart, the contemporary trends of physical maturation, the anthropometric characteristics of contemporary adolescents;

– motor development of adolescents; national charts of aerobic fitness and different physical fitness tests;

– secular changes in physical fitness and anthropometric characteristics of contemporary Slovenian adolescents with data from 10 and 20 years ago and a comparison of these changes to those of their peers from other countries;
– shifts in the distributions of physical fitness performance over the past 20 years;
– changes in biological maturation, body size and body shape over the past 20 years;
– healthy lifestyle habits of adolescents (daily physical and other activities, screen time, food habits, smoking);
– active commuting to and from school;
– sporting activity of adolescents (frequency, organisational form, sport disciplines);
– health of adolescents (self-perception, health problems);
– parents' attitudes about physical activity of their adolescents (their support for sporting activity of their child, their opinion about the importance of physical education);
– physical activity level of adolescents, their sedentary behaviour and energy expenditure;
– characteristics of sleeping patterns of adolescents;
– psychological attitudes for physical activity in adolescents (motives, self-concept, mental health);
– barriers for physical activity of adolescents.

In addition to descriptive research goals, we also set some prediction goals:
– the influence of the socioeconomic baseline profile and home environment attributes on the outcomes, such as physical fitness, overweight and obesity, physical activity/inactivity habits, body composition;
– the bidirectional associations of sleeping patterns, physical activity and sedentary behaviour in adolescence;
– biological maturation as a predictor of physical fitness of adolescents;
– physical fitness as a determinant of body composition, healthy lifestyle, health, self-concept, academic achievements;
– health risks and protective factors in adolescents, in relation to overweight and obesity, level and type of physical activity, aerobic fitness and general physical performance;
– physical activity habits and physical fitness in relation to motives for physical activities and self-concept;
– healthy lifestyle habits of adolescents, such as daily physical and other activities, commuting to school, screen time, sleeping patterns food habits and smoking, in relation to energy expenditure, physical fitness and body fat.

Ethics approval and ethical considerations

Approval of the National Medical Ethics Committee of the Republic of Slovenia was obtained in May 2014 (ID 52/03/14). In advance of the study, we visited all the schools, informed them about the research project and asked them to participate in the study. Having fully informed the adolescents and their parents about the aims of the study and its protocol, we obtained written positive consents from the parents or legal guardians of all participating adolescents. Participation of adolescents was voluntary, and they were able to withdraw from the whole study or from any part of it at any time.

The compiled database does not include any personal identifications, and the identity codes of the participants are kept separately at a secure place in accordance with the Slovenian legislation on data protection. All future reporting and publishing of the data will be anonymous. Schools, parents and adolescents are kept informed of the progress of the study through our web pages and the personal presentations of findings at the schools.

Study design

The ACDSi is a cross-sectional, sentinel approach study that has been carried out in the same secondary schools every ten years since 1994. In order to fulfil our research goals, we planned to include 1,600 adolescents with 200 in each age and sex group. According to our experiences in previous study cycles and other recent studies on the target group, we estimated a 60% response rate; therefore, we sampled around 2,700 adolescents.

Study site setting

The school principals and local mayors were first contacted about a year before the start of the study and were asked for their consent to include the schools in the study. After receiving the consent, we visited each school to explain the details of the study to the school staff, students and parents, and arranged the coordination of activities in each school. All the selected schools agreed to participate in the study. Six months before the measurements, we set the exact dates of measurements, and the schools integrated the measurements into their yearly work plans. A month before the measurements, the schools received precise organisational instructions and the measurement schedule for each participating class. Finally, a few days before the measurements, we arranged the organisational specifics with each school.

In every school, one of the physical education teachers was assigned to serve as a coordinator. The coordinators, who performed their duties during their usual work time and were not additionally funded, helped with the distribution and gathering of consent forms and parents' questionnaires, with informing other teachers and personnel in school about the goals and organisation of the measurements, with setting up the measurement schedule, with making reservations of required facilities, with arranging the meals for the measuring team and the meal schedule for the measured adolescents, and with arranging sleeping facilities for the measuring team, if required. Coordinators were in daily contact with the principal investigators and were informed in detail about the operational level of the study. Half of the coordinators had previous experiences because they had already served as coordinators in the previous cycles of the study.

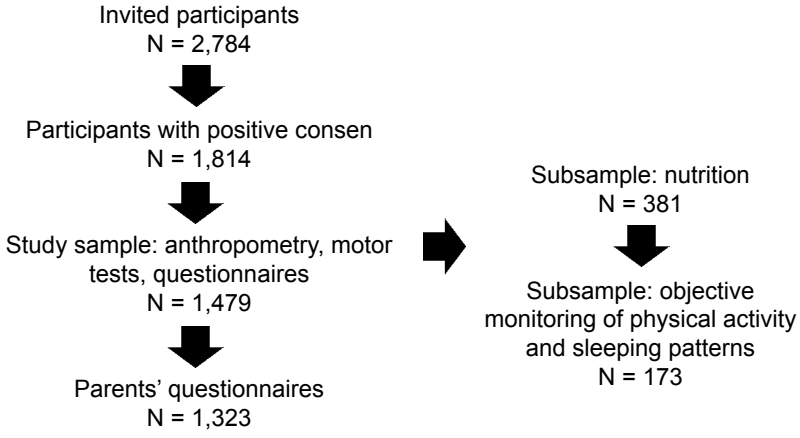
Sample

Schools served as the primary and classes as the secondary sampling units. We obtained the numbers of classes and students per class in each school from the school records. The numbers of students from every school were set according to the national secondary-school educational programme and project site; the ratio of students in secondary-school

educational programmes corresponded to the ratio of all students in Slovenia (according to the Statistical Office of the Republic of Slovenia's data). In this way, we assured the national representativeness of the sample not only by gender, age and geographical location but also according to the secondary school programme.

We then randomly selected the required number of classes from each school. If the number of students from selected classes in an individual school did not correspond to the required number, we randomly selected students from other classes of the same schooling year. After the required number of students from each school had been set, the consent forms were distributed to their parents. The major problem at this stage of research was to obtain the consent forms of the first-year students since the measurements started at the beginning of the school year, thus making the time-frame very narrow in this regard.

Figure 1: Flow chart of the ACDSi 2014 study sample



All parents of the sampled adolescents were asked to sign the consent form about the participation of their children in the study. Each parent also received a description of the study and was instructed to review the details of the study on the Slovenian web page of the study. Parents were also instructed to contact one of the principal investigators if they needed any additional information. Positive consent was obtained for 1,814 students (65% response rate). Some adolescents who had consent were not present on the days of the measurements, were ill or injured, or were not sufficiently healthy to participate. Overall, 1,479 adolescents completed all motor tests and anthropometric measurements, which is 81.5% of all adolescents with positive consent or 53% of the invited participants and represents around 5% of the entire secondary-school population (N=27,638) in Slovenia in 2014, according to the official Statistical Office of the Republic of Slovenia data.

Table 3: The ACDSi 2014 study sample by sex and age

Age (y)	Boys (N)	Girls (N)
14	41	58
15	185	193
16	165	174
17	173	169
18	137	112
19	34	22
20+	8	8
Sum	743	736

**Age is truncated to integer, e.g. 15.0 to 15.9 is 15*

Adolescents were asked to fill in guided web questionnaires, and the parents of adolescents were asked to complete the paper versions of short questionnaires. The return of the questionnaires from parents proved to be a difficult task; after a few interventions, we ended up with 1,323 completed questionnaires (around 90% of all measured adolescents). A subsample of 15-year-olds from all schools was also asked to participate in a physical activity (N = 173) and nutrition (N = 381) study.

Main methods of data collection

All of the tests and protocols utilised in the ACDSi are standard procedures and have been well validated for adolescents of this age (see Table 4).

Table 4: Summary of the data collection undertaken in the ACDSi 2014

Method of data collection	Target group	Research area
Physical fitness examination: SLOfit and EUROFIT protocols	Adolescents 15–19 y	aerobic fitness, motor performance
Anthropometric examination: standard anthropometric procedures	Adolescents 15–19 y	anthropometry, blood pressure, biological maturation
Web-based questionnaire: SHAPES physical activity questionnaire	Adolescents 15–19 y	physical activity habits, sedentary activities, social influences, social-economic environment
Web-based questionnaire	Adolescents 15–19 y	sporting activity, health, sleep,academic achievements
Web-based questionnaire: EMI-2 motivation questionnaire	Adolescents 15–19 y	motivation for physical activity

Web-based questionnaire: SDQ II self-concept questionnaire	Adolescents 15–19 y	self-concept
Web-based questionnaire: SDQ behavioural screening questionnaire	Adolescents 15–19 y	mental health
Questionnaire	Parents of adolescents 15–19 y	social-economic environment, birth weight, height and gestational age of child, parents attitude to physical activity
Multiple-sensor body monitors	Adolescents 15 y	physical activity levels, sedentary activities and energy expenditure, sleeping patterns
24-h recall of food intake	Adolescents 15 y	Nutrition
Food frequency questionnaire	Adolescents 15 y	Nutrition
Personal medical charts	Adolescents 15 y	Health problems

Organisation and performance of testing

Motor testing, anthropometric measurements and questionnaire testing were carried out between 8th September and 1st October 2014. The measurements were organised between 8.00 and 14.00 and lasted two or three days, depending on the school's size. Each of the three groups was managed by a group leader, and the coordination between all three groups (anthropometry, motor testing and questionnaires) was managed by a measurement leader. All the measuring equipment that was not standard school gym equipment was brought to the school by the research team. All testing equipment was routinely calibrated each day throughout the testing period. The web questionnaire for adolescents was previously pilot-tested twice in a school that was not included in the study.

Every adolescent was present for measurements on two days. On the first day of measurements, a part of the participants completed all anthropometric measurements and the multi-stage fitness test. At the same time, the other part of the adolescents completed the motor testing. Before or after these tests in both days adolescents completed the web questionnaires. On the second day of the measurements, the two groups of adolescents switched roles. Anthropometric measurements were carried out in small gyms or classrooms with room temperatures between 20 and 24 °C. The motor testing was carried out in school gyms at the same temperatures and the running tests at the schools' outdoor facilities when the temperature was above 10 °C, without rain and without wind. The web questionnaires were completed in schools' computer rooms with up to 25 adolescents, segregated by sex. Several measurement waves per day were organised with between 40

to 60 participants per wave (half of adolescents being at the anthropometry measurement and the other half at motor testing) and each wave lasted as much as 60 to 75 minutes.

After the first day of measurements at individual schools, the parent questionnaire was handed out to every adolescent with instructions to return it the next day.

The objective physical activity measurements and sleeping pattern measurements were carried out from mid-September to end-November 2014. One hundred and seventy-three 15-year-old adolescents wore SenseWear armband multiple-sensor physical activity monitors from Thursday to Wednesday, 24 hours a day.

Dietary questionnaires and interviews were performed from 10 September 2014 until 22 December 2014.

In accordance with our approval of the National Medical Ethics Committee of the Republic of Slovenia, according to which school physicians are allowed to provide anonymized data from students' medical charts, the medical records of adolescents will be obtained from school physicians in 2016 and 2017 after the database of other measurements is completed and cleaned.

Physical fitness tests

Our concept of physical fitness is not restricted to the limited information provided by laboratory-based measures of peak aerobic power (Macfarlane 2001) but includes a variety of well-known field-based motor performance tests, for which a good lineage of our data from previous cycles of the ACDSi study exists. Therefore, the physical fitness tests were performed and scored using SLOfit (Strel & Šturm 1982; Strel, Šturm & Ambrožič 1982; Strel et al. 1997) and EUROFIT protocols (CDDS 1983). All testing protocols used have been tested on a sample of the Slovenian population to validate their measuring characteristics, and they have been proved to be appropriate for use in the selected population (Šturm 1970, 1977). The measurements in the ACDSi 2014 included 14 physical fitness tests (Table 5).

The 20-s tapping test was performed on an electronic armplate (Elan, Begunje, Slovenia); handgrip strength was measured with a Jamar hydraulic hand dynamometer (Bolingbrook, IL, USA); heart rate was monitored with Polar F11 heart-rate monitors (Polar Electro, Kempele, Finland). The testing sessions began with brief (up to 10 min) light warm-up tasks. Subjects performed all the motor test barefoot (except 30, 60- and 600-m run tests) in their shorts and t-shirts. Before each test, a student investigator explained the execution of a test to an adolescent. During the testing, the adolescents were not additionally verbally encouraged. If an adolescent failed to correctly perform a test, it had to be repeated. Energetically less demanding tests were repeated twice. Resting heart rates were documented 1 min, 2.5 min, and 5 min after the start of relaxed lying-down rest.

Anthropometric measurements

Anthropometric measurements were carried out according to the standard protocols (Lohman et al. 1988). During anthropometric measurements, adolescents wore light clothes, and their feet were bare. Only non-invasive standard anthropometric measurements

were performed. Before the measurement of body height and body mass, adolescents were asked to self-report their body height and body mass.

Table 5: Measured items in ACDSi 2014

Physical fitness tests
- 20-s plate tapping test
- Standing broad jump
- 60-s sit-up test
- Polygon backwards test
- Sit and reach test
- Shoulder circumduction test
- 30-s drumming test
- Flamingo balance test
- Flexed arm hang test
- Handgrip strength test
- 30-m sprint test
- 60-m sprint test
- 600-m run test
- Resting heart rate test
- 20-m multi-stage fitness test

Physical activity
- 6-day objective monitoring of physical activity patterns and energy expenditure
- SHAPES questionnaire
- Barriers to habitual physical activity

Nutritional habits and smoking
- School Fruit Scheme Questionnaire
- Food Frequency Questionnaire
- 2 x 24-h recall
- Dietary Supplement Questionnaire

Motivation for physical activity, self-concept and mental health
- EMI-2 questionnaire
- SDQ II questionnaire
- SDQ behavioral screening questionnaire

Health status
- Kidscreen-10 questionnaire
- Medical records

Sleep quality
- Pediatric Daytime Sleepiness Scale
- 6-night objective sleep monitoring

Anthropometric measurements
- Self-reported height
- Self-reported weight
- Height
- Weight
- Sitting height
- Age at menarche (girls only)
- Shoulder width (biacromial)
- Pelvis width (biiliocristal)
- Ankle width (bimalleolar)
- Femoral width (biepicondylar femur)
- Elbow width (biepicondylar humerus)
- Wrist width (lateral-medial stylion)
- Arm length (acromion-dactylion)
- Leg length (iliospinale)
- Foot length
- Triceps skinfold
- Biceps skinfold
- Suprailiac skinfold
- Supraspinal skinfold
- Subscapular skinfold
- Anterior thigh skinfold
- Medial calf skinfold
- Forearm circumference
- Mid-upper arm circumference relaxed
- Mid-upper arm circumference flexed
- Gluteal thigh circumference
- Mid-thigh circumference
- Waist circumference (illiac crest)
- Hip circumference (the widest part of hips)
- Blood pressure
- Parents' self-reported height
- Parents' self-reported weight
- Parents' reported birth weight of child
- Parents' reported birth height of child

Body height, sitting height and leg length were measured with a GPM 101 anthropometer (Siber & Hegner, Zurich, Switzerland). Body mass was measured to the nearest 100 grams using a portable SECA 799 electronic scale (SECA, Birmingham, UK). The electronic scale was checked for accuracy every time it was moved. Anthropometric widths were measured to the nearest mm by GPM 106 and 108 spreading callipers (Siber & Hegner, Zurich, Switzerland). Diameters, skinfolds and circumferences were measured on the right side of the body. Diameters were measured to the nearest millimetre using a Martin-type sliding calliper (Siber & Hegner, Zurich, Switzerland). Skinfolds were measured to the nearest millimetre with Harpenden fat callipers (Baty International Ltd., Burgess Hill, UK). Three measurements were taken at each measuring site. Circumferences were measured once on the right side and on the trunk to the nearest millimetre with a TEC non-stretchable narrow anthropometric tape (Rollfix, Hoechstmass, Germany).

In addition to anthropometric measurements, blood pressure was taken using an automated Omron M6 blood pressure machine and paediatric cuffs (Omron Healthcare Co., Ltd., Kyoto, Japan). Each adolescent was introduced to the machine, the cuff was chosen and adjusted according to the size of adolescent's arm, and then the adolescent sat quietly and alone for at least two minutes prior to measurement. Resting systolic and diastolic blood pressure were measured in the sitting position using the adolescent's left arm. Two measurements were then taken at three-minute intervals. The mean of the two measurements will be used for analysis.

Some anthropometric data and the data on biological age were also acquired via questionnaires; girls reported their age at their first menarche, and the parents reported their children's birth length, weight and gestational age, their own body height and weight and their own birth date. They were also asked to report on their adolescent's height and weight.

Physical activity

The assessment of physical activity/inactivity patterns and correlations for physical activity of adolescents were made with the School Health Action, Planning and Evaluation System (SHAPES) physical activity questionnaire (Leatherdale et al. 2008). The original SHAPES physical activity questionnaire consisted of 45 multiple-choice questions presented in a four-page machine-readable booklet. We created a web-based questionnaire for our study; however, the layout of the questionnaire remained identical to the original version. Two items require a seven-day recall of vigorous physical activity (VPA) and moderate physical activity (MPA), respectively. VPA was defined as 'jogging, team sports, fast dancing, jump-rope, and any other physical activities that increase your heart rate and make you breathe hard and sweat.' MPA was defined as 'lower intensity physical activities such as walking, biking to school, and recreational swimming.' Responses were provided by indicating the number of hours (0–4 h) and 15-min increments (0–45 min) that each type of physical activity was performed for each day of the previous week. Thus, intensity, duration, and frequency data are collected, and weekday versus weekend analyses are possible. In addition to the two core physical

activity items, the questionnaire also asked about participation in physical activities (e.g., physical education, strength training, intramural sports, varsity sports, commuting to school), sedentary activities (e.g., watching television, playing video games, homework), social influences (e.g., peer and parental influences), self-perceptions of weight status and athletic ability. To the original SHAPES physical activity questionnaire, items about dog ownership in the family and social-economic environment were added; the latter included age, education, employment status, and the physical activity level of parents. The SHAPES physical activity questionnaire has acceptable reliability and validity (Adamo et al. 2009; Chinapaw et al. 2010; Wong, Leatherdale, and Manske 2006), and it is suitable for use in large-scale school-based data collections for child and adolescent populations (Wong, Leatherdale, and Manske 2006). After it was translated to Slovenian and prior to our measurements, we tested it for reliability and validity at one of the schools not included in the sample and established that it has acceptable validity and reliability. Additionally, all adolescents answered a few questions about perceived barriers for habitual physical activity via the web-based questionnaire.

Parents were asked about some of the specifics of the social-economic environment, such as family budget and parents' age and employment status. They were also asked about their own attitude to physical education in comparison to other school subjects. They had to self-report their current weight and height, and also the birth weight and height of their adolescent.

A subsample of 15-year-olds was included in the energy expenditure and physical activity pattern study and wore the SenseWear Pro[3] multiple-sensor body monitors (BodyMedia Inc., Pittsburgh, PA, USA) during four weekdays and during the weekend. Our research team distributed the multiple-sensor body monitors person-to-person at schools. Information about the SWA body monitors use was presented to the adolescents orally; at the end of the information session, accelerometers were distributed. The SWA body monitor was attached to the back of each subject's upper right arm, over the triceps muscle, halfway between the acromion and olecranon processes. Adolescents were instructed to wear the armbands during the entire day for six consecutive days (including four weekdays and both weekend days), except during bathing or other water activities. If adolescents had to remove the armband monitors for any other reasons (sports competitions, swimming, etc.) they had to report it. In addition, adolescents received a brochure about using SWA body monitors. Teachers were also informed about the procedure and were asked to remind adolescents to wear the devices every day.

[3] SenseWear armbands (SWA) are part of a new generation of monitors that combines accelerometry with other physiological signals and has contributed to progress in physical activity assessment (Corder et al. 2008). The monitors combine a two-axis accelerometer with heat flux, temperature and galvanic skin response sensors. These additional physiological data enable the SWA to detect and measure the physical activity of the lower and upper body and to detect the change in energy expenditure associated with load carrying, change of grade and non-ambulatory physical activity, thus eliminating the drawbacks of physical activity assessment based only on accelerometer data (Fruin & Rankin 2004). Validation studies comparing the SWA with gold reference methods have found that the former shows no systematic bias in energy expenditure (Calabro et al. 2013) or sleep among children and adolescents (Sorić et al. 2013).

Data from all the sensors are averaged over one-minute periods, and these data were stored and subsequently downloaded to a computer. For the analysis of the SWA data, the most recent child-specific exercise algorithms will be used (SenseWear Professional software version 8.1, BodyMedia Inc., Pittsburg, PA, USA). The outcome variables are total daily energy expenditure, active energy expenditure and the duration of physical activity performed at various intensities.

Nutritional habits and smoking

In order to obtain insight into adolescents' lifestyles, we included a few questions on nutritional habits (breakfast consumption, frequency and contents of meals and use of dietary supplements) and on possible smoking habits, we used the School Fruit Scheme questionnaire for children and adolescents, developed by the Slovenian National Institute of Public Health. The subsample of 15-year-olds was included in the nutrition study and completed a food frequency questionnaire (FFQ), 24-hour recall and additional questionnaire about dietary supplement use to obtain more thorough insight in food consumption pattern and nutritional status (adequacy of energy, macro- and micronutrient intake regarding their sex, age, body mass, body height and level of physical activity). We used semi-quantitative FFQ adapted for children and adolescents from German KIGGS study (Department of Epidemiology, German Institute of Human Nutrition, Potsdam-Rehbrücke) called 'Was ist du?' (Mensink & Burger 2004), which includes questions about frequency and the amount of 65 food items consumed during the past one year. Trained interviewers performed a repeated 24-hour recall of food intake within two weeks to one-month interval according to the EFSA general principles (EFSA, 2009). The additional questionnaire about dietary supplement use (as well as medicines containing high concentrations of nutrients) included questions about detailed information about dietary supplement products: the name of the product, brand name and pharmaceutical form of the product and information about the frequency of use in the past year, separately for every season.

Motivation for physical activity, self-concept and mental health

To examine the relationship between adolescents' motivational regulations and their levels of leisure-time physical activity or inactivity, we used the Exercise Motivations Inventory – 2 (EMI-2) by Markland and Ingledew (1997).

We used the SDQ II questionnaire (Marsh 1990; Marsh & Redmayne 1994; Marsh et al. 1994) to assess the self-concepts of the adolescents. The questionnaire is based on the model of academic and non-academic components of self-conception (Shavelson, Hubner, and Stanton 1976).

Psychological difficulties of adolescents were assessed by using the Strengths and Difficulties Questionnaire (SDQ) (Goodman, Meltzer & Bailey 1998)

All the questionnaires for adolescents were web-based. When adolescents came to the computer room, each adolescent received a unique identification number that was

used for login. After login, they started completing the questionnaire while the present members of the measuring team gave additional individual explanations if necessary.

Health status

Self-evaluation of health status was assessed in adolescents via the Kidscreen-10 questionnaire (Ravens-Sieberer et al. 2010). This tool proved to have sufficient validity for assessment of health-related quality of life. In addition to the questionnaire, we will use the Slovenian network of school physicians to obtain some information on adolescents' health status from their previous regular medical examinations (chronic and acute illnesses, injuries, blood pressure, blood lipids, haemoglobin, blood sedimentation, sight, hearing, status of motor apparatus).

Sleep quality

In order to assess sleep-related behaviours, we used the Pediatric Daytime Sleepiness Scale (Drake et al. 2003) with additional questions on the in-bed time and out-of-bed time during weekdays and weekends. We used SenseWear armbands to assess the quality of sleep on the subsample of 15-year-olds.

Statistical considerations

Data treatment

All hard copy data were manually entered into a database and checked for transcription errors. All data were entered once and then checked for outliers. Different types of statistical analyses are to be performed based on research questions and type of data.

Considerations in relation to clusters within the study sample

The ACDSi study is school-based, and it is, therefore, possible that there are more differences in adolescents between schools than within individual schools (cluster effect). This means that specific statistical methods are needed to take this into account.

Multilevel analyses

Descriptive and simple bivariate analyses are to be performed to describe the distribution of data and to establish simple associations between potential predictor variables and the relevant outcome variables. In addition, a multivariate multilevel analysis is to be performed.

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References

Adamo, Kristi B., Stephanie A. Prince, Andrea C. Tricco, Sarah Connor-Gorber & Mark Tremblay. 2009. A comparison of indirect versus direct measures for assessing physical activity in the pediatric population: A systematic review. *International Journal of Pediatric Obesity* 4(1): 2–27.

Calabro, Miguel Andres, Jeanne M. Stewart & Gregory J. Welk. 2013. Validation of pattern-recognition monitors in children using doubly labeled water. *Medicine and science in sports and exercise* 45(7): 1313–22.

CDDS. 1983. Testing Physical Fitness: *EUROFIT. Experimental Battery - Provisional Handbook*. Strasbourg: Council of Europe.

Corder, Kirsten, Ulf Ekelund, Rebekah M. Steele, Nicholas J. Warhead & Søren Brage. 2008. Assessment of physical activity in youth. *Journal of Applied Physiology* 105(3): 977–87.

EFSA. 2009. General principles for the collection of national food consumption data in the view of a pan-European dietary survey. *EFSA Journal* 7(12): 1435.

Fruin, Margaret L. & Janet Walberg Rankin. 2004. Validity of a multi-sensor armband in estimating rest and exercise energy expenditure. *Medicine and Science in Sports and Exercise* 36(6): 1063–9.

Goodman, Robert, Howard Meltzer & Veira Bailey. 1998. The Strengths and Difficulties Questionnaire: A pilot study on the validity of the self-report version. *European Child & Adolescent Psychiatry* 7(3): 125–30.

Jurak, Gregor, Marjeta Kovač & Gregor Starc. 2013. The ACDSi 2013 – The Analysis of Children's Development in Slovenia 2013: Study protocol. *Anthropological Notebooks* 19(3): 123–43.

Leatherdale, Scott T., Steve Manske, Suzy L. Wong & Roy Cameron. 2008. Integrating research, policy, and practice in school-based physical activity prevention programming: The School Health Action, Planning, and Evaluation System (SHAPES) Physical Activity Module. *Health Promotion Practice* 10(2): 254–61.

Lohman, Timothy G., Alex F. Roche & Reynaldo Martorell. 1988. *Anthropometric standardization reference manual*. Champaign: Human Kinetics Books.

Macfarlane, Duncan J. 2001. Automated metabolic gas analysis systems: A review. *Sports Medicine* 31(12): 841–61.

Mai J. M. Chinapaw, Lidwine B. Mokkink, Mireille N. M. van Poppel, Willem van Mechelen & Caroline B. Terwee. 2010. Physical Activity Questionnaires for Youth: A systematic review of measurement properties. *Sports Medicine* 40(7): 539–63.

Markland, David & David K. Ingledew. 1997. The measurement of exercise motives: Factorial validity and invariance across gender of a revised Exercise Motivations Inventory. *British Journal of Health Psychology* 2(4): 361–76.

Marsh, Herbert W. & Robyn Sutherland Redmayne. 1994. A Multidimensional Physical Self-Concept and Its Relations to Multiple Components of Physical-Fitness. *Journal of Sport & Exercise Psychology* 16(1): 43–55.

Marsh, Herbert W. 1990. *The Self-Description Questionnaire – I (SDQ I). Manual*. Sydney: University of Western Sydney.

Marsh, Herbert W., Garry E. Richards, Steven Johnson, Lawrence Roche & Patsy Tremayne. 1994. Physical Self-Description Questionnaire - Psychometric Properties and a Multitrait-Multimethod Analysis of Relations to Existing Instruments. *Journal of Sport and Exercise Psychology* 16(3): 270–305.

Mensink, Gert B. M. & Martina Burger. 2004. Was ist du? Ein Verzehrshäufigkeitsfragebogen für Kinder und Jugendliche. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz* 47(3): 219–26.

Ravens-Sieberer, Ulrike, Michael Erhart, Luis Rajmil, Michael Herdman, Pascal Auquier, Jeanet Bruil, Mick Power, Wolfgang Duer, Thomas Abel, Ladislav Czemy, Joanna Mazur, Agnes Czimbalmos, Yannis Tountas, Curt Hagquist & Jean Kilroe. 2010. Reliability, construct and criterion validity of the KIDSCREEN-10 score: a short measure for children and adolescents' well-being and health-related quality of life. *Quality of Life Research* 19(10): 1487–500.

Shavelson, Richard J., Judith J. Hubner & George C. Stanton. 1976. Validation of construct interpretations. *Review of Educational Research* 46(3): 407–11.

Soric Maroje, Mirjana Turkalj, Darija Kucic, Ivana Marusic, Davor Plavec & Marjeta Misigoj-Duraković M. 2013. Validation of a multi-sensor activity monitor for assessing sleep in children and adolescents. Sleep Medicine 14(2): 201–5.

Strel, Janko & Jože Šturm. 1982. *Predlog informacijskega sistema za ugotavljanje in spremljanje motoričnih sposobnosti in morfoloških značilnosti šolske mladine v SR Sloveniji* [*A proposal of the information system for diagnosis and monitoring of motor abilities and morphological traits of school-youth in SR Slovenia*]. Ljubljana: Visoka šola za telesno kulturo. Inštitut za kineziologijo.

Strel, Janko, Jože Šturm & Franci Ambrožič. 1982. *Ovrednotenje informacijskega sistema za ugotavljanje in spremljanje motoričnih sposobnosti in morfoloških značilnosti šolske mladine v SR Sloveniji. I. faza* [*Evaluation of information system for diagnosis and monitoring of motor abilities and morphological traits of school-youth in SR Slovenia*]. Ljubljana: Visoka šola za telesno kulturo. Inštitut za kineziologijo.

Strel, Janko, Franci Ambrožič, Marjeta Kovač, Bojan Leskošek, Jože Štihec & Jože Šturm. 1997. *Sports Educational Chart*. Ljubljana: Ministry of Education and Sport.

Šturm, Jože. 1970. *Zanesljivost in faktorska struktura 28 testov telesne zmogljivosti 8- in 12-letnih učenk in učencev nekaterih ljubljanskih osnovnih šol* [*Reliability and factorial structure of 28 motor performance tests for 8- and 12-year old students of some of elementary schools in Ljubljana*]. Ljubljana: College for Physical Culture.

Šturm, Jože. 1977. *Zanesljivost motoričnih testov* [*Reliability of motor performance tests*]. Ljubljana: College for Physical Culture.

Wong, Suzy L., Scott T. Leatherdale & Steve R. Manske. 2006. Reliability and validity of a school-based physical activity questionnaire. *Medicine and Science in Sports and Exercise* 38(9): 1593–600.

Povzetek

Študija ARTOS je desetletna študija o biološkem, psihološkem in socialnem razvoju mladostnikov. V letu 2014 je opisana študija vključevala 1.479 mladostnikov in mladih odraslih med 14. in 24. letom starosti. Od njenih začetkov v letu 1970 smo študijo oblikovali kot interdisciplinarno študijo fizične antropologije, kineziologije, psihologije in sociologije. V tretjem krogu merjenja adolescentov smo študijo razširili še na področje javnega zdravja. Cilj študije je ugotavljanje sekularnih trendov telesnega in gibalnega razvoja adolescentov v Sloveniji glede na njihove psihološke, socialne in zdravstvene determinante, ki oblikujejo življenjske sloge sodobnih mladostnikov. Prispevek opisuje protokol študije ARTOS 2014 z vidika njene organizacije, vzorčenja in metod.

KLJUČNE BESEDE: mladostniki, telesni razvoj, gibalni razvoj, telesni fitnes, zdravje

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