An assessment of health status and health behaviours in adolescents: main points and methods of the SOPKARD-Junior programme

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Abstract

Introduction: The study involved preparing and implementation a model of complex screening programme for adolescents and comparison of anthropometric examinations between the population of the SOPKARD-Junior programme and representative sample of Polish children in the same age.
Material and methods: The screening programme in 14–15 year old pupils (n = 282) included: anthropometric, blood pressure, echocardiographic, electrocardiographic, carotid arteries, kidney and thyroid ultrasound examinations, as well as respiratory, dental and masticatory system, orthopaedic, psychological and psychiatric assessment. Blood and urine tests were also performed. The results of anthropometric examinations from the SOPKARD-Junior and OLAF programmes were used for comparative analysis.
Results: Statistically significant (p < 0.001) differences between young people from Sopot and their peers in the general Polish population were found in height (+3.61 cm for boys), body mass (+5.19 kg for boys and +3.99 kg for girls), body mass index (+0.99 kg/m^2 for boys and +1.33 kg/m^2 for girls),

waist circumference (+4.52 cm for boys and +4.52 cm for girls) and hip circumference (+2.51 cm for boys). The highest attendance rate was achieved for examinations performed in school (e.g. anthropometric and blood pressure measurements – n = 268; 95%) and the lowest for the echocardiograpy performed in local hospital (n = 133; 47%). The mean score of the programme quality (scale 1–6) assessed by children was 4.63. **Conclusions:** The SOPKARD-Junior programme represents an attempt to develop a model of screening assessments for teenagers in Poland. Preliminary results of the SOPKARD-Junior programme indicate small differences in the biological development of Sopot youth in comparison with their peers from Polish population of the OLAF programme. The high attendance rate on research conducted at the school indicate that proposed health examinations in adolescents are acceptable and feasible.

Key words: prevention, screening, health behaviour, research methods, health assessment survey.

Introduction

In accordance with the principal documents on health published by the World Health Organisation and the European Union, health education and disease prevention in children and adolescents and early detection of non-communicable diseases should be priorities of health policies [1, 2]. It has been conclusively established that building up the health potential already in childhood markedly delays the development of diseases, and early detection of a disease or a high risk of a disease offers better chances of a cure. Comprehensive prevention that addresses the main non-communicable diseases and dental caries has been shown to result in considerable benefits for the normal development and functioning of adolescents and for the reduction of risk factors in adult life [1, 3, 4].

In Poland, there is a very well-organized system of newborn screening and vaccination programme for children and adolescents. However, poor health education and the delayed diagnosis of many non-communicable diseases and risk factors, particularly cardiovascular disease and cancer, still remain significant problems [5]. This is why "A programme for early detection of risk factors for lifestyle diseases SOPKARD-Junior" has been launched in Sopot. The primary aim of this programme is to perform a comprehensive assessment of the adolescent population of Sopot in terms of health status, health behaviours, and the prevalence of diseases and risk factors.

A detailed and comprehensive assessment of health and health behaviours among lower secondary school students will identify the principal needs in the areas of education, prevention and treatment of non-communicable diseases and oral diseases. In future, it will facilitate the planning of interventions in adolescents. The SOPKARD-Junior programme will also serve as a pilot study offering a chance to gain organisational and economic experience and to identify the fundamental barriers to implementation of similar programmes in Poland at the municipality level.

The reason for launching the SOPKARD-Junior programme was the lack of any systematic studies comprehensively assessing health in lower secondary school students. As a result, there are no available guidelines specifying which tests should be introduced and when to maximise the effectiveness and benefits of prophylaxis. Therefore, in these circumstances, it seems useful to establish a uniform system of preventive examinations for teenagers. This system would be ready for use in the near future. According to this, the main aim of this paper was to describe research methods used in the SOPKARD-Junior programme, which were developed based on scientific evidence and international standards. If this group of children is found to be affected by a large number of health problems requiring treatment or active prevention, the SOPKARD-Junior programme in subsequent years will be carried out in a younger group of children.

Sopot was selected for its proximity to the Medical University of Gdansk (MUG) and the history of very successful collaboration with the local government in Sopot initiated already in 1999. The Municipality of Sopot is not only unique as far as interventional programmes are concerned, but is also capable of ensuring their funding over a period of several years.

Material and methods

All the second-grade lower secondary school students of the three state schools in Sopot were invited to participate in the SOPKARD-Junior programme in 2013–2014. The child's calendar age was calculated from the difference between the date of assessment and the date of birth and expressed in the decimal system. Subjects aged between $\geq$ 13.5 and $<$ 14.5 years were included in the group of 14-year-olds and those aged between $\geq$ 14.5 and $<$ 15.5 years were assigned to the group of 15-year-olds.

This publication discusses the assessments performed as part of the SOPKARD-Junior programme in 2013–2014. The study was accepted by the Ethics Committee and assigned the number NKEBN/510/2006. All the assessments performed as part of the programme were free of charge. The

only condition that had to be met for a child to be included in the programme was the provision of written assent by the child and written consent by the child's parent/legal guardian.

The assessments in the SOPKARD-Junior programme have been designed to enable identification of three groups of children: (1) a group of completely healthy children, (2) a group of healthy children at increased risk of developing individual non-communicable diseases (the target group for prophylactic activities), and (3) a group of patients diagnosed with non-communicable diseases (the group where treatment should be provided).

The SOPKARD-Junior programme started with an informational and educational meeting with parents. During the meeting, the list of the planned assessments and their aims were presented to the parents and written consent for their child's participation in the project was obtained. At that time a questionnaire was also completed about any chronic illnesses the child might be suffering from, about any family history of cardiovascular disease and about the child's allergologist, orthopaedic and dental care.

All the assessments were performed by specialists from the medical units of the MUG and University Clinical Centre (UCC) in Gdansk. Most assessments were performed on the premises of the participating schools. The only exceptions were the ultrasound and echocardiographic assessments, which were performed at the UCC. The parents booked these assessments by telephone or email. The visits in the SOPKARD-Junior programme were scheduled to accommodate the participants' needs. Upon the completion of the programme, all the results were analysed and each parent was given an information sheet with the results of the so-called "health passport" along with information on how to proceed further if any abnormalities were detected.

The package of assessments performed as part of the SOPKARD-Junior project consisted of the following:

Anthropometric examination

Anthropometric examination methods were based on the research methodology used in the nationwide OLAF programme, which included 17,573 children [6]. The result of this project are up-to-date centile charts of body height, weight and body mass index (BMI), representative for children and adolescents. The following parameters were evaluated during the anthropometric examination: weight (using Seca electronic scales), height (using the Leicester Weight Measure, to the nearest 1 mm, in an upright standing position with shoes off), BMI, skinfold thickness (at four sites: biceps, triceps, scapula, abdomen), and circumference (waist, hip, right arm, left arm). Waist circumference was measured as the smallest circumference of the trunk between the lower costal margins and the iliac crests at the end of a free expiration. Hip circumference was measured at the level of the greatest circumference of the buttocks below the iliac crests. Each parameter was measured twice. If the difference between the two measurements exceeded 3 cm, a third measurement was taken. The questionnaires covered such issues as cigarette smoking, passive smoking, overweight relatives, self-rating of one's own body weight, infections in the past 2 weeks, immunisations, traumatic injuries, procedures and menarche (in girls).

Blood pressure and pulse measurement

Blood pressure and pulse were measured using the Accutorr Plus monitor (Datascope Corp.). After the arm circumference was measured, an appropriately sized blood pressure cuff was selected in accordance with the ESC recommendations for each subject [7]. The cuff was placed on the right arm at the level of the heart. Three readings of blood pressure and pulse were taken 1 to 2 min apart. The measurement was performed at rest with the child seated in a chair with their arm resting on the table and their back against the chair's backrest. The mean of the second and third readings was recorded as the final value.

Echocardiographic assessment

Echocardiographic assessments were performed by an experienced paediatric cardiologist using a GE Vivid 6 system in 2D-mode, M-mode and Doppler mode. Blood flows across the valves and chamber sizes were assessed and compared with weight-specific norms. Ejection fraction (EF) and shortening fraction (SF) were calculated.

Electrocardiographic assessments

In order to perform a routine assessment of the electrical activity of the heart a 12-lead ECG tracing was recorded at rest using a telemetric recorder, M-Trace Mobile PC (M4Medical, Lublin, Poland). In order to assess the contribution of cardiac autonomic modulation a 15–20-minute high-fidelity ECG (4 kHz; PowerLab, AdInstruments, Australia) was obtained from a single bipolar lead from the chest, with the patient resting in the supine position. The influence of the autonomic nervous system (ANS) on heart rhythm was assessed on the basis of heart rate variability (HRV) analysis. Stationary time series of 512 RR intervals (RRi) were used for the analysis of HRV (Kubios HRV Pro software, Kuopio, Finlandia). The following parameters were determined in the time domain: the mean RR interval (mRRi), standard deviation of RR intervals

(SDNN), root mean square of successive differences between adjacent normal RR intervals (RMSSD) and the proportion of successive RRi that differed by more than 50 ms (pNN50). The spectral analysis of HRV was performed using the fast Fourier transform (FFT) method in the following bands of frequency: VLF (0.0033–0.04 Hz), LF (0.04–0.15 Hz) and HF (0.15–0.4 Hz) [6]. The values of SDNN, LF spectral power and total spectral power (TSP = LF + HF) were taken to be the markers of the autonomic regulation of heart rhythm, RMSSD and HF to be the markers of vagal regulation, and the LF/HF ratio to be the marker of the sympathetic component of the autonomic regulation of heart rhythm.

This assessment also involved determination of pulse wave velocity (PWV) at rest in the supine position by applanation tonometry using piezoelectric sensors (TZ-1012; AdInstruments, Australia) after simultaneously recording the pulse wave from the carotid and the femoral arteries in 10 consecutive cardiac cycles. Pulse wave onset in each cardiac cycle was determined as the maximum of the second derivative of the plethysmograph, followed by determination of the pulse transit time (PTT) between the carotid and femoral pulses. PWV was calculated by dividing PTT by the difference of the distance from the heart to the femoral artery and the distance from the heart to the carotid artery.

Ultrasound assessment

Ultrasound assessments were performed by doctors using B&K Panther 2002 and GE Logiq 3 systems with wide band convex 2–6 MHz and linear 6–10 MHz transducers. No special patient preparation was required. The scanning was performed with the patient supine, and then prone. Kidney size was determined by measuring three dimensions: the length, width and thickness of the kidney. This was followed by measurements of the cortical layer thickness in the lower third of the kidney and at the lower pole. Measurement of the central echo complex and of the pyelocalyceal system width was performed. Position of the kidney, thickness of the adipose capsule surrounding the kidney, the outline of the fibrous capsule and the corticomedullary echoic structure were assessed.

Ultrasound assessment of the thyroid was performed using a linear 6–10 MHz transducer. Dimensions of each lobe (length, width, thickness) were determined separately. Thyroid volume was calculated from the ellipsoid formula.

Respiratory assessment including allergies

As part of the respiratory diseases and allergy module a questionnaire was completed and pulmonary function tests were performed. Parents were asked to complete a questionnaire assessing the presence and severity of their child's allergy and respiratory symptoms. Information was collected about any previously diagnosed disorders and their treatment, if any. Pulmonary function tests consisted of spirometry and the assessment of exhaled nitric oxide concentration. Spirometry was performed using Lungtest 500. The following parameters were assessed: vital capacity (VC), forced expiratory volume in 1 s (FEV_1), peak expiratory flow (PEF), FEF 25–75% (forced expiratory flow through the medium-sized and small bronchi) and FEV_1%VC (Tiffeneau index). Exhaled nitric oxide concentration was measured with a nitric oxide analyser, FeNo (from ProVita). Pulmonary function tests were performed at rest, using disposable mouthpieces. Bronchial reactivity testing was not performed. All the tests were carried out in the school nurse's room on the premises of the participating schools and were performed by qualified technicians with many years' experience in working with children. If the screening tests revealed any abnormal findings, the participant was invited for a full pulmonary function assessment.

Dental assessment

History was taken and physical examination was performed in the school dentist's office on the premises of the participating schools (each of the participating schools had a school dentist's office). The questionnaire (see online appendix) assessed how much the subjects knew about periodontal diseases and the diseases of the oral mucosa (knowledge that bleeding gums are a sign of gum inflammation, knowledge of risk factors, including smoking and placement of tongue piercings in the oral mucosa). The questionnaire assessed health-promoting behaviours with respect to periodontal tissues and oral mucosa (frequency of brushing teeth, frequency of using accessories for oral hygiene, frequency of dental check-ups). The clinical examination involved oral hygiene assessment using the Approximal Plaque Index (API), assessment of gum inflammation based on the modified Sulcus Bleeding Index (mSBI), and probing depth (PD). A WHO calibrated periodontal probe was used, defining periodontal treatment needs by assessing the Community Periodontal Index of Treatment Needs (CPITN). The severity of dental caries was assessed with the mean DMF index (where D stands for Decayed and refers to the presence of teeth with active primary or secondary caries, M stands for Missing and refers to teeth removed for dental caries, and F stands for Filled and refers to teeth with fillings). Assessment by physical examination also included the oral mucosa. The mucosa was examined for potential

pathologies and mucogingival complex abnormalities (abnormal attachments of the frenula, presence of gingival recession).

Masticatory system assessment

In 2014, the scope of dental diagnostic evaluation was expanded to include an assessment of the masticatory system consisting of a clinical examination and a questionnaire. The physical examination was performed using a specially prepared clinical examination chart and consisted of extraoral and intraoral examination. The following were assessed during the extraoral examination: facial symmetry, tenderness over the trigeminal nerve areas, lymph nodes, condition of mastication muscles, temporomandibular joint pain and acoustic symptoms. The intraoral examination included measurement of mandibular free range of motion, assessment of the condition of the oral mucosa, including dental impressions in the cheeks and tongue, assessment of deglutition type, analysis of centric and extracentric occlusion, assessment of occlusion height and occlusion plane, and evaluation for malocclusion. A dental diagram was also performed with particular emphasis on the presence of non-carious lesions. The clinical examination was carried out with the standard single-use dental examination kit consisting of a dental mirror, a dental probe, a pair of dental tweezers, Bausch articulating paper, and a single-use TheraBite ruler.

The questionnaire assessment (see online appendix) consisted of two parts: a questionnaire for the child and a questionnaire for the parent. The questionnaire for the child was divided into the following themes: general factors, eating habits, oral parafunctions, pain in the head, neck and the back of the neck, and information about sleep. The questionnaire also included the Epworth Sleepiness Scale (ESS) assessment table. The questionnaire for the parent included questions concerning the presence of systemic diseases, specialist treatment, temporomandibular joint symptoms, and questions about the child's breathing and sleep.

Orthopaedic assessment

The orthopaedic assessment consisted of history and physical examination. Locomotor system statics and dynamics were assessed and a visual evaluation of gait was performed. The physical examination included evaluation of foot shape and dynamics with particular emphasis on competence of the windlass mechanism and the tibialis posterior muscle test. Achilles tendon was assessed against gastrocnemius muscle function. Lower limb axes were analysed with particular emphasis on valgus and varus deformities. Range of motion in the ankle joints, knee joints, hip joints and spinal joints was assessed. Position of the pelvis and spine on weight bearing was assessed. The questionnaire for the parent concerned the child's orthopaedic treatment.

Psychological and psychiatric assessment

The psychological and psychiatric assessment was performed in two steps. The first step involved administering a psychological questionnaire to all the subjects (see online appendix), and in the second step subjects with severe depressive symptoms were invited to undergo a psychiatric examination. The prevalence of depressive symptoms was assessed using the Beck Depression Inventory (BDI) and the Krakow Depression Inventory. Stress level, social support and prevalence of smoking, alcohol use and illicit drug use were assessed using a self-constructed questionnaire. The analysis of health behaviours and lifestyle in the context of family environment, peer environment and school environment was carried out using the Health Behaviour in School-aged Children (HBSC) questionnaire recommended by the WHO. It is an international survey conducted periodically among teenagers. Currently, the research network includes more than 40 countries in Europe and North America. Poland joined the HBSC network in 1989 and has so far participated in 7 series of studies. Representative findings from the HBSC survey are being broadly disseminated and provided to national governments and policymakers in the sectors of health and education as well as to scientific institutions and local governments [8].

Subjects with depressive symptoms revealed in the course of questionnaire assessments were invited for a psychiatric examination. The criterion for establishing the presence of depressive symptoms was a BDI score of 10 or more. The aims of the psychiatric examination performed as the second step of the psychiatric assessment were to carry out a clinical assessment of the child's condition and to verify the diagnosis of depression.

Blood and urine laboratory tests

Each subject underwent blood sampling after 8 to 12 h of fasting and an overnight rest. The samples were transported at room temperature in secured boxes labelled "biological material". The blood samples were delivered to the laboratory as soon as possible (within 2 h) after collection. The specimens were analysed at the Central Clinical Laboratory, UCC in Gdansk. The battery of laboratory tests included determination of blood levels of urea nitrogen, C-reactive protein, total choles-

terol, high-density lipoprotein (HDL) cholesterol, triglycerides, cystatin C, electrolytes, thyroid-stimulating hormone (TSH), creatinine, uric acid, glucose, and peripheral blood cell counts. A urinalysis was performed and levels of potassium, sodium, creatinine and albumin were determined in the morning urine specimen. The detailed methodology of the tests mentioned above is described in Table I. The requested laboratory tests required collection of the following samples:

- 5 ml of venous blood into a tube with a separation gel (and a clot activator in order to separate the serum) for determination of biochemical parameters,
- 2 ml of venous blood into a tube with sodium fluoride for determination of glucose,
- 2 ml of venous blood into a tube with EDTA for blood cell counts,
- 10 ml of urine into a clean dry tube for urinalysis and determination of biochemical parameters.

In the 2014 edition of the SOPKARD-Junior programme, children found to have an elevated glucose level above 99 mg/dl had the parameter retested in May 2015. A total of 9 children were qualified for additional testing.

Assessment of the programme quality

In order to find out what opinions were held on the SOPKARD-Junior programme, in 2014 anonymous surveys were carried out with the programme participants. The questionnaire consisted of 8 closed-ended questions and 1 open-ended question, and was divided into three modules in which the participant could rate the programme overall (Module 1) and each assessment separately (Module 2) on a "marking" scale from 1 to 6 (where 1 was the lowest mark and 6 was the highest) and express their opinions on the SOPKARD-Junior programme in the final, open-ended question (Module 3).

During the programme, in-depth interviews were conducted with the participants' parents and with all the head teachers and selected teachers of the schools where the programme was run.

Anthropometric examination results obtained in the SOPKARD-Junior programme were compared with the results of the national OLAF programme.

Due to the age differences within the study population (14- and 15-year-olds), weighted means for the results obtained in 14- and 15-year-olds were used for the comparative analysis of the mean results in the OLAF and SOPKARD-Junior programmes (Table II). The weights were selected according to the number of subjects in individual groups, i.e. they corresponded to the ratios of the number of 14- and 15-year-olds to the total number of subjects in both groups and summed up to 1.

Statistical analysis

A two-sided statistical test for between-group comparisons of means was used to demonstrate the presence or absence of differences between the means in the SOPKARD-Junior and the OLAF studies. An alpha significance level of 0.05 was adopted. Statistical analyses were performed using the two-sided Student's *t*-test for independent samples at the α significance level of 0.05. The analysis was carried out using Stata 11/Statistica 11.

Results

In 2013, consent for participation in the study was obtained for 153 (81%; 74 girls and 79 boys) of the 188 invited individuals (82 girls and 106 boys) and in 2014 for 129 (87%; 59 girls and 70 boys) of the 149 invited individuals (61 girls and 88 boys). The mean age was 14 years and 5 months (range: 13 years and 4 months to 15 years and 4 months). Table III provides data on the number of schoolchildren assessed in 2013 and 2014 and on the percentage of all children consented to participate in the SOPKARD-Junior programme who were assessed in each of the assessment categories. Attendance rates for the assessments completed at the UCC and MUG were lower than for the assessments completed at the participating schools. The highest attendance rate was achieved for anthropometric examination with blood pressure measurement (n = 268; 95%) and the lowest was observed for the ultrasound assessment of the kidneys, thyroid and carotid arteries (n = 150; 54%) and the echocardiographic assessment (n = 133; 47%) (Table III).

The anthropometric examination was completed by 77 boys and 72 girls in 2013 and by 63 boys and 56 girls in 2014. In total, 155 14-year-olds (76 girls and 79 boys) and 133 15-year-olds (52 girls and 61 boys) were assessed.

A significant difference in mean body mass was demonstrated between the children participating in the SOPKARD-Junior programme and the children who were assessed in the OLAF programme. Body mass was 5.19 kg higher in boys and 3.99 kg higher in girls. The statistical test also demonstrated a significant difference in mean height (3.61 cm) among boys. Significant differences were also observed in mean BMI values. Body mass index was higher in children from Sopot: 0.99 kg/m^2 higher in boys and 1.33 kg/m^2 higher in girls. Analysis of waist circumference in the children assessed in the SOPKARD-Junior programme revealed higher values compared to those in their peers who participated in the OLAF programme (the difference was 4.52 cm in boys and 4.52 cm in girls). A significant difference was also observed

Table I. Methodology of the laboratory tests

Test	Specimen	Method	Analyser/manufacturer	Bias (%)	Reproducibility (%)	Repeatability (%)
Serum sodium	Blood/serum	Integrated Chip Technology (ICT)	Architect c8000/Abbott Laboratories	0.65	0.26	1.08
Urinary sodium	Urine portion	Integrated Chip Technology (ICT)	Architect c8000/Abbott Laboratories	–2.05	0.49	1.03
Serum potassium	Blood/serum	Integrated Chip Technology (ICT)	Architect c8000/Abbott Laboratories	1.6	1.00	2.305
Urinary potassium	Urine portion	Integrated Chip Technology (ICT)	Architect c8000/Abbott Laboratories	–2.5	1.11	1.25
TSH	Blood/serum	Chemiluminescent microparticle immunoassay (CMIA)	Architect I2000/Abbott Laboratories	–3.8	2.35	6.37
Serum creatinine	Blood/serum	Enzyme-based method	Architect c8000/Abbott Laboratories	–1.9	0.92	2.61
Urinary creatinine	Urine portion	Enzyme-based method	Architect c8000/Abbott Laboratories	10.1	1.86	2.2
Triglycerides	Blood/serum	Glycerol phosphate oxidase	Architect c8000/Abbott Laboratories	–4.7	0.79	1.83
HDL cholesterol	Blood/serum	Selective Detergent accelerator	Architect c8000/Abbott Laboratories	–8.7	1.9	2.94
LDL cholesterol	Blood/serum	Calculated from the Friedewald formula				
Total cholesterol	Blood/serum	Enzyme-based method	Architect c8000/Abbott Laboratories	–0.28	0.55	1.5
Urea nitrogen	Blood/serum	Urease method	Architect c8000/Abbott Laboratories	3.05	0.64	2.58
Urinary albumin	Urine portion	Immunoturbidimetry	Architect c8000/Abbott Laboratories	8.5	1.17	4.14
Cystatin C	Blood/serum	Immunonephelometry	BN II /Siemens Healthcare	9.6	1.19	1.8
CRP (C-reactive protein)	Blood/serum	Immunoturbidimetry	Architect c8000/Abbott Laboratories	2.8	2.18	3.34
Uric acid	Blood/serum	Uricase	Architect c8000/Abbott Laboratories	5.58	1.07	2.04
Glucose	Blood/plasma	Hexokinase/G6PD	Architect c8000/Abbott Laboratories	–1.84	1.34	1.8
Peripheral blood count	Whole blood					
White blood cell count (WBC)		Fluorescence flow cytometry using a semiconductor laser	XE-2100/Sysmex	–5.39	1.04	1.6
Red blood cell count (RBC)		Impedance method with hydrodynamic focusing		0.62	0.47	0.43
Haemoglobin (HGB)		Absorptive photometry using sodium lauryl sulfate (a non-cyanide method)		0.79	0	0.51
Platelet count (PLT)		Impedance method with hydrodynamic focusing		–7.44	2.96	1.09
Urinalysis	Urine portion	iChemVELOCITY Strips dipstick tests	IRICELL/Beckman Coulter			

in hip circumference in boys, with the difference between the SOPKARD-Junior and the OLAF programmes being 2.51 cm.

The questionnaire assessing the quality of the programme in 2014 was completed by 104 participants. Results from Module 1 of the questionnaire showed that more than 86% of the respondents would be willing to participate in the programme once again, while 7% did not have an opinion.

Nearly 70% of the participants rated the idea of running the SOPKARD-Junior programme at their school as "very good", 22% as "good", and 8% as "average". None of the respondents considered the prophylactic tests offered by the SOPKARD-Junior programme to be a "bad" or "very bad" idea. The analysis additionally showed that more than 92% of the teenagers were of the opinion that programmes such as the SOPKARD-Junior programme should be run all over Poland.

In Module 2, anthropometric examination with blood pressure measurement achieved the highest average rating (5.12) and spirometry the lowest (3.55). The remaining study assessments rated between 4.88 and 4.59. The average result for all the assessments in total was 4.63.

The two most common responses to the open-ended question that comprised Module 3 were positive opinions on the project and negative comments about the person who performed spirometry.

Detailed results from all aspects of the SOPKARD-Junior programme will be published soon.

Discussion

The study involved preparing and implementing a model of screening assessments for adolescents, evaluating anthropometric parameters in the study group of children, and assessing the quality of the programme. The transformations Poland and the rest of the world have gone through over the past few decades have significantly changed the structure of health behaviours and morbidity, the organisation of healthcare, and the spectrum of available diagnostic methods and prophylactic tests [5]. We are witnessing major demographic changes and the rapid ageing of societies, which will increase healthcare expenditure. According to international organisations, we need to start educating, preventing, detecting risk factors and diagnosing non-communicable diseases sooner than so far [2]. The so-called diseases of civilisation (diseases whose development is strongly associated with specific health behaviours and lifestyles) have now become the greatest threat to our health [9]. It therefore seems that early detection of increased risk of atherosclerosis and cancer is very important, as it may significantly reduce the incidence of these diseases or at least delay their development.

Table II. Comparison of the results of anthropometric examination with blood pressure measurement between the adolescents participating in the SOPKARD programme and the adolescents participating in the OLAF programme

Parameter	Boys					Girls				
	SOPKARD *N* = 138		OLAF		Statistical significance *P*-value	SOPKARD *N* = 128		OLAF		Statistical significance *P*-value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Height [cm]	173.41	5.53	169.8 *N* = 1390	5.6	< 0.0001	163.49	5.00	162.98 *N* = 1463	4.27	0.2624
Body mass [kg]	63.57	8.58	58.38 *N* = 1389	8.51	< 0.0001	57.91	8.66	53.92 *N* = 1463	6.85	< 0.0001
BMI [kg/m^2]	21.06	2.53	20.07 *N* = 1389	2.43	< 0.0001	21.57	2.72	20.24 *N* = 1463	2.29	< 0.0001
Waist circumference [cm]	75.82	6.79	71.3 *N* = 1409	5.58	< 0.0001	72.35	7.92	67.83 *N* = 1501	4.81	< 0.0001
Hip circumference [cm]	91.18	5.98	88.67 *N* = 1404	5.54	< 0.0001	91.53	6.38	90.67 *N* = 1500	4.99	0.1372

Thanks to the complete collaboration between the eight clinical teams and the very effective cooperation with the local government, the SOPKARD-Junior programme seems to be an optimal platform where new recommendations for modern prophylactic tests in children and adolescents can be formulated.

In order to establish similarities and differences between the population of the SOPKARD-Junior programme and a representative nationwide sample of Polish children, the HBSC questionnaire was used, adopting the same methodology. The results of the SOPKARD-Junior programme will be compared with the representative results from the HBSC survey obtained in the population of Polish peers [8].

Based on the available literature, the proposed set of diagnostic assessments in the SOPKARD-Junior programme seems justified as serving the purpose. A separate factor that may indicate the need for regular performance of these assessments as part of screening is their high prevalence and the possibility to actively prevent them.

The potential costs of the assessments are an important factor that should also be taken into consideration. The authors of the SOPKARD-Junior programme intend to take all these elements into account in order to publish suitable recommendations.

Anthropometric measurements have long been an element of the standard paediatric examination. These are simple tests that allow the child's somatic development to be assessed. The numeric values of body mass and height must be related to the appropriate age- and sex-specific reference values, which is normally done using percentile charts. In recent years, BMI has gained widespread acceptance as an indicator of nutritional status, and appropriate age- and sex-specific percentile charts are also available for this parameter [10]. Waist circumference and hip circumference are important parameters for the diagnosis of obesity and assessment of body fat distribution. For these parameters, thanks to the nationwide research conducted as part of the OLAF project, threshold values have been established for Polish children and adolescents above which cardiovascular risk significantly increases [11].

Height and body mass in adolescents are not only an indicator of the individual's health status but also a reflection of the population's prosperity. Gross domestic product (GDP) per capita is considered a key measure of prosperity. Wide variation in GDP per capita depending on the region has long been observed in Poland. Studies conducted in Poland have shown that a higher level of GDP per capita is associated with a higher risk of developing overweight and obesity in children. A study by Grajda *et al*., which analysed the prevalence of overweight and obesity depending on the region, showed that the region at the highest significant risk of overweight and obesity is the Mazovian Province [12]. This province has consistently had the highest GDP per capita. In 2013, according to the Central Statistical Office of Poland (GUS), the Warsaw subregion ranked first, while the Tricity subregion ranked fourth [13]. It was therefore reasonable to expect that the mean values of body mass and height in the adolescent population of Sopot would be higher than those for the whole

Table III. Data on the number and percentage of children included in the SOPKARD programme who completed a specified assessment in 2013 and 2014

Examination	Number of subjects	Percentage of all eligible subjects
Anthropometric examination	268	95
Blood pressure assessment	268	95
Echocardiographic assessment	133	47
Electrocardiographic assessment	153	100
Ultrasound assessment (of the kidneys, thyroid and carotid arteries)	150	54
Spirometry and assessment of exhaled nitric oxide concentration	242	86
Dental check-up with a particular emphasis on the periodontium	266	94
Masticatory system assessment	115	89*
Orthopaedic assessment	99	77*
Psychological and psychiatric assessment	265	94
Blood and urine tests	251	89
Programme quality assessment**	104	81

**Assessment performed only in 2013. **Assessment performed only in 2014.*

adolescent population of Poland. This diversity is confirmed by a study by Kułaga *et al.*, which — based on data published by the Central Statistical Office of Poland – introduced the distinction between the so-called "Eastern Wall", where GDP per capita was below 80% of the national average, and the "Rest of the Country", where GDP per capita was above 80% of the national average. When the mean body mass and height of the children divided according to these criteria were compared, differences in these parameters were found, which were smaller amongst the children and adolescents from the "Eastern Wall" region [14].

Blood pressure measurement is a basic indicator of cardiovascular function. Early detection and treatment of hypertension considerably reduces the risk of many diseases and complications. The current ESH guidelines and *The Fourth Report of the National High Blood Pressure Working Group* recommend blood pressure measurement in children below 3 years of age. Unfortunately in Poland, blood pressure monitoring continues to be largely ignored. It is worthy to keep in mind, that elevated blood pressure in children and adolescents can reflect kidney abnormalities. In children hypertension is mostly secondary due to kidney diseases. In adults the majority of hypertension is so called idiopathic hypertension.

Cardiovascular screening in this age group is particularly important due to the considerable sports activity in this age and its intensification. Appropriately planned cardiovascular screening allows identification of those children and adolescents in whom exercise is either contraindicated or associated with an increased risk of cardiac death in professional athletes [15]. Some cardiovascular abnormalities (hypertrophic cardiomyopathy, mitral valve prolapse) may be asymptomatic in children and adolescents, and their detection is only possible with diagnostic methods of high sensitivity. Echocardiography is among the most useful tools enabling that. It can detect abnormalities before they manifest clinically. Screening echocardiograms are performed very rarely due to the high cost and limited availability of the equipment and sufficiently qualified staff [16]. Thanks to screening echocardiography, however, it is possible to detect considerably more abnormalities compared to other available methods. As demonstrated in a screening programme of 2072 adolescents aged 13 to 19 years, mitral valve regurgitation alone was present in as many as 0.7% of the screened individuals [17].

HRV assessment is a recognised cardiovascular risk indicator in adults, although there is still no consensus as to its prognostic value in adolescents [18, 19]. Attempts have, however, been made to establish age group- and sex-specific reference values [19]. An association has been documented between decreased autonomic heart control with reduced vagal drive and increased sympathetic activity, and decreased physical activity [20], increased risk of cardiovascular morbidity [21], obesity, dyslipidaemia or glucose intolerance [18, 20] and mood disorders and depression [22].

Pulse wave velocity (PWV) assessment also seems important, as multicentre cardiovascular screening programmes in children of a wide range of age have demonstrated that functional signs of vessel stiffness precede the development of adverse structural changes in the arterial wall and are an unfavourable prognostic factor for the development of atherosclerosis [23]. Measurement of PWV in adolescents has been shown to identify arterial wall dysfunction before morphological changes in arterial walls become evident. Reference values of PWV for adolescents have been published for the oscillometric [24], sonographic [25] and tonometric [26] methods. In a comparative study, the latter method has been shown to be the most reliable [27].

It turns out that determination of urinary albumin excretion (UAE) and the urinary albumin-to-creatinine ratio (UACR) in adolescents is extremely important. One of our previous studies in 14-year-old inhabitants of Sopot showed that 16% had elevated UAE and more than 11% had elevated UACR [28]. In view of the above, in subsequent years, the scope of renal assessment in the SOPKARD-Junior was expanded to include ultrasonography. When used as a screening tool, ultrasonography can offer early detection of congenital anomalies of the urinary system, which are the most common cause of chronic kidney disease in the paediatric population. This diagnostic method is safe for the examining physician and for the patient alike, and allows detection of early structural changes in the kidneys suggestive of their injury. According to KDIGO, in addition to laboratory abnormalities, changes visualised in imaging studies, including ultrasound, are alone sufficient for the diagnosis of chronic kidney disease. Ultrasonography is the only screening tool for chronic urinary system diseases that offers such possibilities. This imaging modality can also be used to evaluate an enlarged thyroid and various focal changes, and to diagnose inflammatory parenchymal changes.

The respiratory assessment including allergies carried out as part of the SOPKARD-Junior programme is focused on early detection and treatment of allergies and asthma. This is extremely important in the light of epidemiological data according to which the incidence of these conditions is continually increasing [29, 30]. Spirometry is the principal tool for the evaluation of pulmonary function. Spirometry can detect signs of reversible airway obstruction, which is characteristic of asthma. Measurement of exhaled nitric oxide con-

centration (FeNO) is a modern, non-invasive and completely safe test that provides a new quality in the evaluation of respiratory allergies. Elevated exhaled nitric oxide concentration has been demonstrated in patients with allergic asthma. It has also been shown that the level of exhaled nitric oxide increases upon contact with an inhalation allergen [31]. High FeNO values have also been reported in allergic rhinitis sufferers [32, 33], while low values may be suggestive of cystic fibrosis. In this case, both sensitivity and specificity of this measurement are high. It therefore seems justified to include this test in the battery of screening assessments.

The most commonly used tool for the monitoring of dental caries is the mean DMF index [34], where D refers to active caries, M refers to teeth removed for dental caries, and F refers to teeth with fillings. The results in this respect are very diverse. DMF values in Poland vary around 10 [35]. A study by Molęda-Ciszewska carried out in adolescents living in Sopot demonstrated a lower average DMF, namely 4.95. The author emphasised that the schools where she conducted the study had on their premises dental offices, and pointed to the need to re-introduce dental offices in all the schools in Poland [36].

Periodontal diseases are becoming increasingly common already amongst young people. Early detection and treatment of periodontal diseases is important for stopping disease progression and limiting local complications (i.e. loss of aesthetics and function of the stomatognathic system) and systemic complications (i.e. complications in the cardiovascular, urinary and respiratory systems, and stroke) [37]. In adolescents, the most common periodontal disease is gingivitis with gum bleeding without radiological changes. Aggressive periodontitis associated with very rapid destruction of periodontal tissues is observed less frequently in children and adolescents. Its detectability is often underestimated due to the lack of special dental instruments for periodontal examination at dentist's offices [38].

The term masticatory system dysfunction refers to structural and functional abnormalities of the temporomandibular joints, masticatory muscles and teeth. These abnormalities often cause multiple symptoms, such as headache, pain in the back of the neck, pathological tooth wear and toothache, increased tone of the facial muscles, and acoustic symptoms during movements of the mandible. The location of symptoms and the patients' subjective experiences, such as tinnitus, pain similar to that in trigeminal neuralgia or pain around the teeth, may be the reason for treatment failure. Quite worryingly, this problem is increasingly affecting schoolchildren and adolescents. The reported prevalence of masticatory system dysfunction varies depending on the authors and the adopted criteria, and ranges from 30% to 70% in children and from 60% to 80% in adolescents [39, 40]. The main factors that trigger and exacerbate the symptoms of dysfunction seem to be emotional problems, which – in adolescents attending school – are associated with schoolwork, examinations and making, for the first time in their lives, their own decisions [41].

The structure of the musculoskeletal system in children continues to raise many controversies. Screening assessments of kindergarten and school children very often reveal foot and body posture problems in at least 30% of the screened population. These results stem from the theory which considers valgus deformity and generalised flaccidity of the connective tissue to be pathologies. The facts confirmed by multiple studies are, however, as follows:

1. One in 5 children never develop the correct foot arching.
2. An overwhelming majority of children with flat feet do not experience any pain or any other dysfunctions.
3. Static planovalgus foot deformity is a normal phenomenon during the development of humans.

Recent studies suggest the possibility of spontaneous development of the correct foot arching by 12–13 years of age.

Planovalgus foot deformity may be asymptomatic or symptomatic. The only difference between the two is the presence of symptoms reported by the patient during history taking. Both asymptomatic and symptomatic planovalgus foot deformity have the same structure and function.

Elements that should be considered pathological are: persistent contracture of the lower leg muscles in their posterior compartment, especially the gastrocnemius muscle, and structural and functional asymmetry of the lower limbs. In light of the above, it may be concluded that just like people differ from each other in height, the feet differ in the degree of arching. The specificity of the gait pattern, which is different in every human, should also be emphasised. Gait and locomotion studies consistently demonstrate considerable differences between the correctly formed foot and the foot affected by planovalgus deformity. Two questions therefore remain that continue to cause controversy: what are the indications for correcting and treating planovalgus foot deformity in children, and which methods should be used to do so? [42–44].

The SOPKARD-Junior programme also assessed the psychological and social risk factors for lifestyle diseases and the prevalence of the most common emotional problems in adolescents. Special emphasis was on early detection

of depressive disorders in adolescents. According to the WHO, depression is a serious health problem in the world, being the third most common cause of mortality in adolescents. Depression markedly affects the adolescent patient's functioning in society and at school, influencing their life choices in early adulthood. It also directly and indirectly contributes to the development of other diseases – it is, for instance, a recognised cardiovascular risk factor. Early detection of depression and its risk factors (such as stress, lack of social support, experiencing abuse) and implementation of adequate therapeutic measures might therefore be of great value in preventing depressive disorders and, consequently, other lifestyle diseases in adult life. According to reports from the United States, the prevalence of clinical depression in adolescents is estimated at about 8.3% [45]. Studies of 15-year-olds in Poland have demonstrated depressive symptoms in 27.4% of girls and 19.2% of boys [46]. The prevalence of clinical depression confirmed by medical examination in the population of Polish adolescents is, however, unknown. The SOPKARD-Junior programme is the first programme in Poland to have included a medical evaluation and verification of the diagnosis based on medical criteria in addition to a questionnaire-based assessment of depressive symptoms. The SOPKARD-Junior programme also assessed social factors, including various health-improving and health-deteriorating behaviours in a wider sense, with particular emphasis on smoking cigarettes and using stimulants, including illicit substances. Studies have shown that it is a widespread problem amongst lower secondary school students. In European studies, the prevalence of smoking and alcohol consumption among 12-year-olds has been reported at 19% and 24%, respectively [47]. Early intervention in this area could prevent numerous addictions and diseases a few years later.

Laboratory assessments in the SOPKARD-Junior programme were intended to serve as the basis for drawing up recommendations on a panel of screening tests dedicated to lower secondary school students. In order to establish the child's general health the following screening tests were performed: complete blood count and urinalysis. The CRP was measured to screen for possible inflammation. Renal function was assessed by determining the levels of creatinine, cystatin C, urea nitrogen and uric acid, and by performing urinalysis. Albumin concentration in urine and the ratio of albumin to creatinine in urine were also assessed as the earliest marker of kidney abnormalities. Early detection of lipid abnormalities was ensured by determining the levels of total cholesterol, HDL-cholesterol and triglycerides. The TSH was determined to assess thyroid function and glucose was measured to screen for abnormal glucose levels. A considerable problem was encountered in the interpretation of the laboratory results obtained in the study population of adolescents in the SOPKARD-Junior programme due to the lack of established normal ranges/reference values in the Polish population for at least several important parameters, namely: TSH, total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, and uric acid.

A closing survey in which the participants can anonymously express their opinions on the completed programme seems to be an important and valuable element. An appropriately conducted evaluation allows any health programme to be improved and further developed. It seems extremely important that detailed questions should be asked in such a questionnaire. The responses to the "general" closed-ended questions (Module 1) in the SOPKARD-Junior questionnaire were very positive but did not allow the strengths and weaknesses of the programme to be identified. This was, however, possible based on the responses to the "specific" closed-ended questions (Module 2) and the open-ended question (Module 3). The survey showed that the participants rated spirometry lower than they did the other assessments (3.55 vs. 4.63). The open-ended question allowed the problem associated with this assessment to be identified. The reluctance towards the person performing spirometry may have been caused by the considerable effort the children had to make when completing this assessment.

The SOPKARD-Junior programme was designed to enable the authors to provide recommendations on the assessments considered necessary when carrying out prophylactic medical examinations of children. It was also the authors' intention to compile two scopes of preventive programmes, each with a different configuration of assessments. The first one would be the basic model, the most economical model of a preventive programme within the means of the Ministry of Health, while the second one would include more in-depth assessments that would be co-financed by the local municipality. This recommendation seems necessary given the considerably varied and often suboptimal local health policies within the municipalities in Poland and the considerably varied levels of expenditure these local policies allocate to disease prevention in children.

Obviously, based on the cross-sectional studies completed as part of the SOPKARD-Junior programme, it is not possible to draw any final conclusions on the scope of assessments in preventive programmes. The future uniform scope of assessments should be established based on several years of observation and a follow-up study, in

order to determine which of the detected abnormalities are significant and lead to disease.

Therefore, in the current setting, it seems useful to establish a uniform model of preventive examinations for adolescents based on scientific evidence, a model that will be possible to implement over the coming years.

In conclusion, systematic studies comprehensively assessing health in Polish teenagers are lacking. The only available evidence consists of the results of nationwide and local studies that investigated a single risk factor or a single disease entity. It would therefore be advantageous to launch cross-sectional and observational studies to assess the occurrence of medical, psychological and social determinants of many diseases, which will allow identification of the major needs and the appropriate methods of prevention. The high attendance rate in research conducted at schools and the very positive opinion on the SOPKARD-Junior programme voiced by the participants indicate that such comprehensive, in-depth and intensive (two to three days long) health examinations in adolescents are acceptable and feasible. Implementation of comprehensive screening programmes concerning non-communicable diseases, such as the SOPKARD-Junior programme, requires that – in addition to appropriately planning the assessments and obtaining the funding – the prophylactic goal is also achieved, namely the highest possible attendance for the assessments. The low attendance rate for the assessments carried out at the University Clinical Centre in Gdansk compared to the very high attendance rate at schools indicates the need to prepare and carry out prophylactic examinations mainly on the premises of the schools. The significantly higher body mass index in the population of adolescents in Sopot compared to their peers in the general Polish population, as reported in the OLAF study, suggests the need to implement additional intensive health education programmes for the adolescents living in Sopot and for their parents and teachers. The SOPKARD-Junior programme represents an attempt to develop a model of screening assessments for teenagers in Poland. There is a need for comprehensive, single-stage, multidirectional examinations of teenagers performed at schools.

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Conflict of interest

The authors declare no conflict of interest.

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