**Report**

**2.2.2a Proportion of overweight children (weight for height above plus two standard deviations from the median) under the age of 5 years**

## Introduction

Overweight and obesity are pathological or excessive fat accumulation, representing a health risk. For example, using the method of measuring body mass (BMI) - weight of a person (in kilograms). It is usually considered that a person with a BMI equal to or greater than 30 is a person with a BMI equal to or greater than 25, is overweight.

Overweight and obesity are major risk factors for a variety of diseases, including diabetes, cardiovascular diseases and cancer. Currently, the problem of overweight and obesity, which was previously considered typical only for high-income countries, is becoming widespread in low- and middle-income countries, especially in urban settings.

To date, there is no consensus in the world regarding which approaches and which combinations of health measures will be most effective in preventing childhood obesity in different conditions and different communities. The High-Level Commission on the Elimination of Childhood Obesity is tasked with systematizing the expert opinions of specialists from around the world and proposing recommendations to the WHO Director-General for resolving the current crisis.

No scientific discipline alone can provide a foundation for developing a strategic approach to solving the problem of childhood obesity. Specialists in sociology, public health, clinical research and economics will join forces to develop a consistent plan based on reliable evidence. They will be joined by interested parties from the following areas: maternal and child health and nutrition; health education and awareness; physical education; public policy.

Obesity in children and adolescents is one of the urgent problems of modern health care. Practically all over the world, the number of sick children is steadily growing and doubles every three decades [6]. In the United States in 1976-1980. between the ages of 6 and 11, 7% were obese, and from 12 to 19 years, 5% of children. By the end of the millennium in both age groups, the prevalence of obesity already exceeded 15% [5]. Even in Japan, where still relatively recently, overweight people were relatively rare, the incidence of obesity among schoolchildren 6–14 years old in 1993 was 10%. Currently, in developed countries, up to 25% of adolescents are overweight, and 15% are obese. In the Russian Federation, 5.5% of children living in rural areas and 8.5% in urban areas are obese.

Of great interest is the problem of the connection of obesity in childhood with obesity in the same patients who have become adults. It is estimated that 30–50% of these children retain this disease in the adult period of life. Thus, in the British prospective study, it was shown that of girls whose preschool age was within the 91–95th percentile, by 33 years, 33% had obesity; with the body mass in childhood within the 95–98th percentile - in 44%, and with the body mass over the 98th percentile in childhood by 33 years, obesity persisted in 60% of cases. On the other hand, in the study it was revealed that, of the group of 33-year-olds with a BMI of 25-30, 63% of men and 43% of women were overweight at school age [7]. Among adults with bulimia, childhood obesity was 40%, and among healthy adults it was observed in childhood only in 15%. Almost all studies have shown that the prevalence of obesity is higher among girls. It is revealed that BMI in 33-year-old women rises linearly with a decrease in their menarche age. So, girls with the onset of menarche up to 11 years old at 33 years old have an average BMI of 26.6, and from the menarche age of 15 years have a BMI of 22.5. It is assumed that the low social level in families among girls is associated with obesity to a greater extent than among boys.

**Key facts**

• The number of infants and young children (from 0 to 5 years old) who are overweight or obese has increased worldwide from 32 million in 1990 to 41 million in 2016. In the WHO African Region alone, the number of children who are overweight or obese has increased from 4 million to 9 million over the same period.
• In emerging economies (the World Bank classifies them as low- and middle-income countries), the incidence of overweight and obesity among children is 30% higher than in developed countries.
• If this trend continues, the number of overweight infants and young children will increase to 70 million by 2025.
• Unless action is taken, these infants and young children will continue to be obese in childhood, adolescence, and adulthood.
• Obesity in childhood causes a wide range of serious complications and an increased risk of early development of diabetes, cardiovascular and other diseases.
• Exclusive breastfeeding from birth to 6 months is an important way to prevent obesity in infants.

**The effects of childhood obesity**
Obese children are more susceptible to various health problems in adulthood, such as:
• cardiovascular diseases;
• insulin resistance (often an early sign of soon developing diabetes);
• disorders of the musculoskeletal system (especially osteoarthritis, an extremely disabling degenerative disease of the joints);
• some oncological diseases (intrauterine devices, mammary glands, colon);
• disability.

**Standards**
***Children under 5 years old***

In children under 5 years of age, overweight and obesity are defined as follows:
overweight - if the ratio "body weight / height" exceeds the median value specified in the Standard Indicators of Physical Development of Children (WHO), by more than two standard deviations;
obesity - if the ratio "body weight / height" exceeds the median value specified in the Standard Indicators of Physical Development of Children (WHO), by more than three standard deviations;

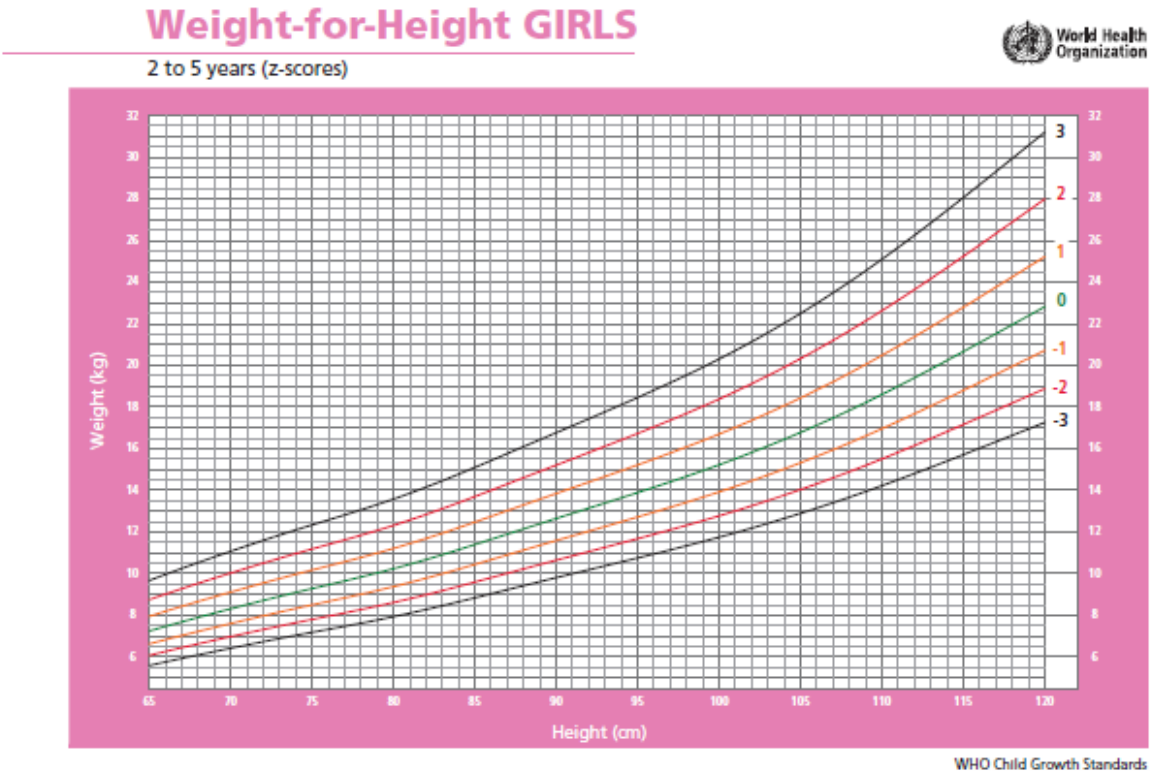



Figure 1. Weight for Height of girls at the age of 2 to 5 years (z-scores)

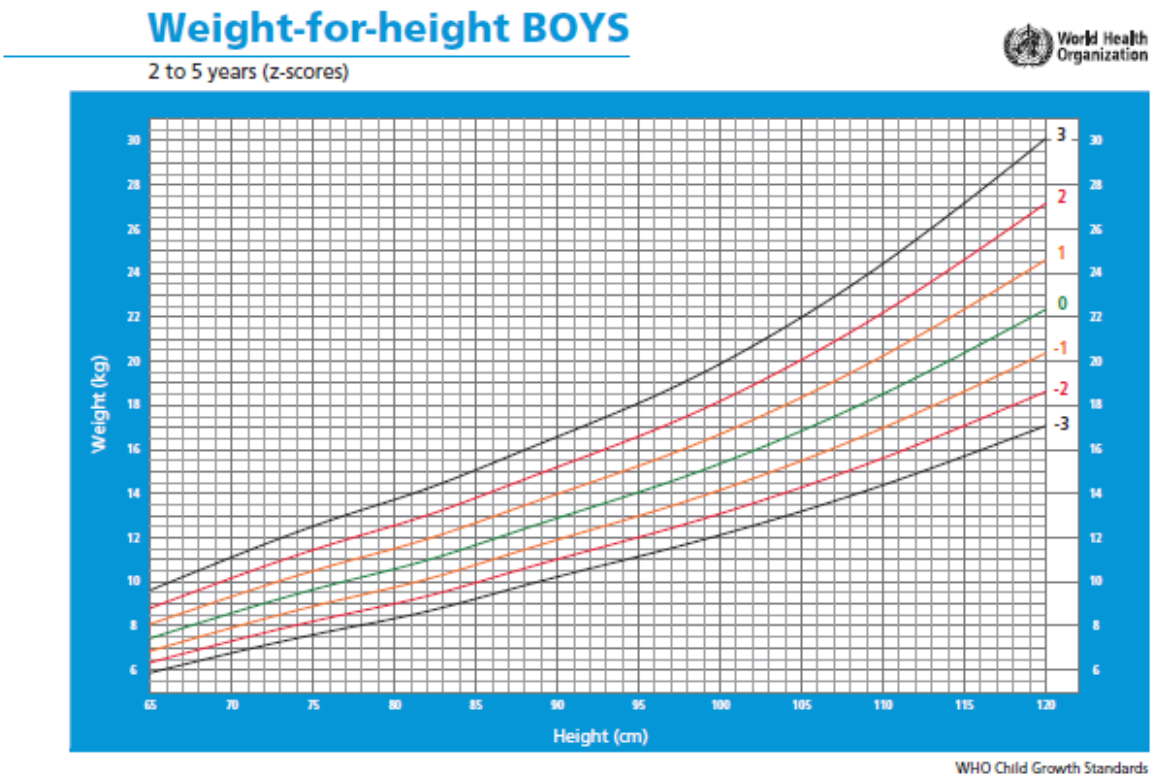



Figure 2. Weight for Height of boys at the age of 2 to 5 years (z-scores)

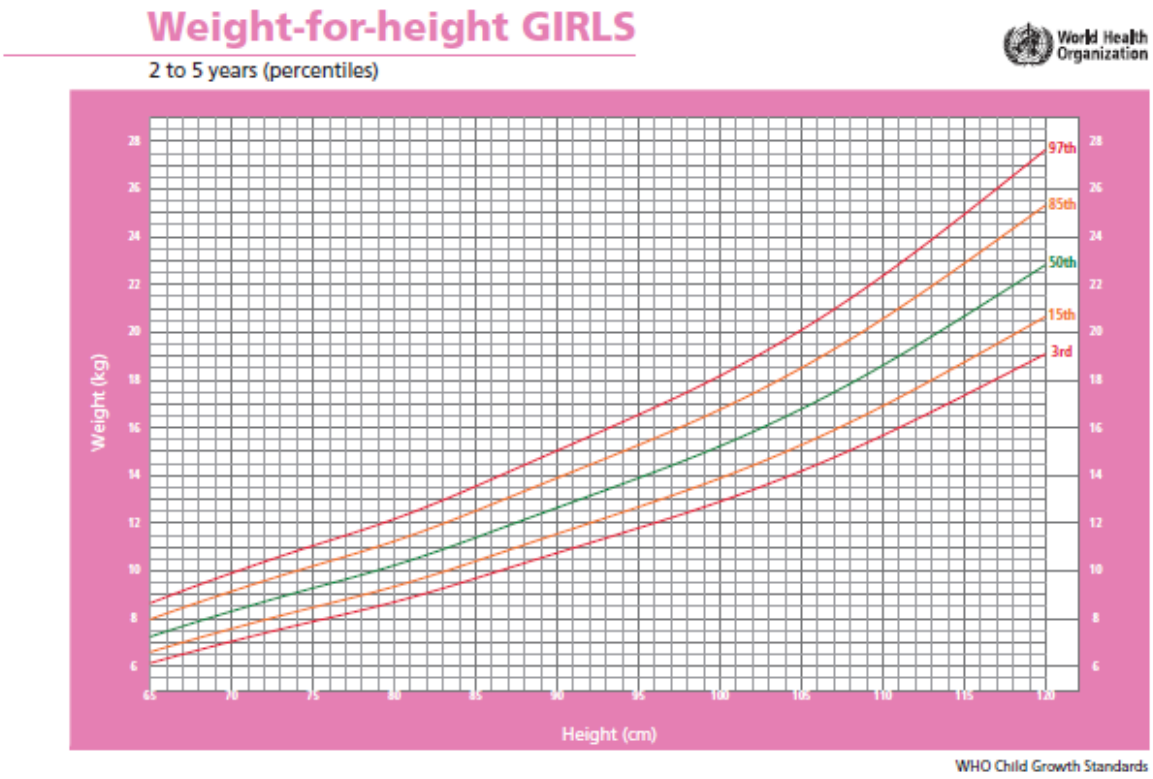



Figure 3. Weight for Height of boys at the age of 2 to 5 years (percentiles)

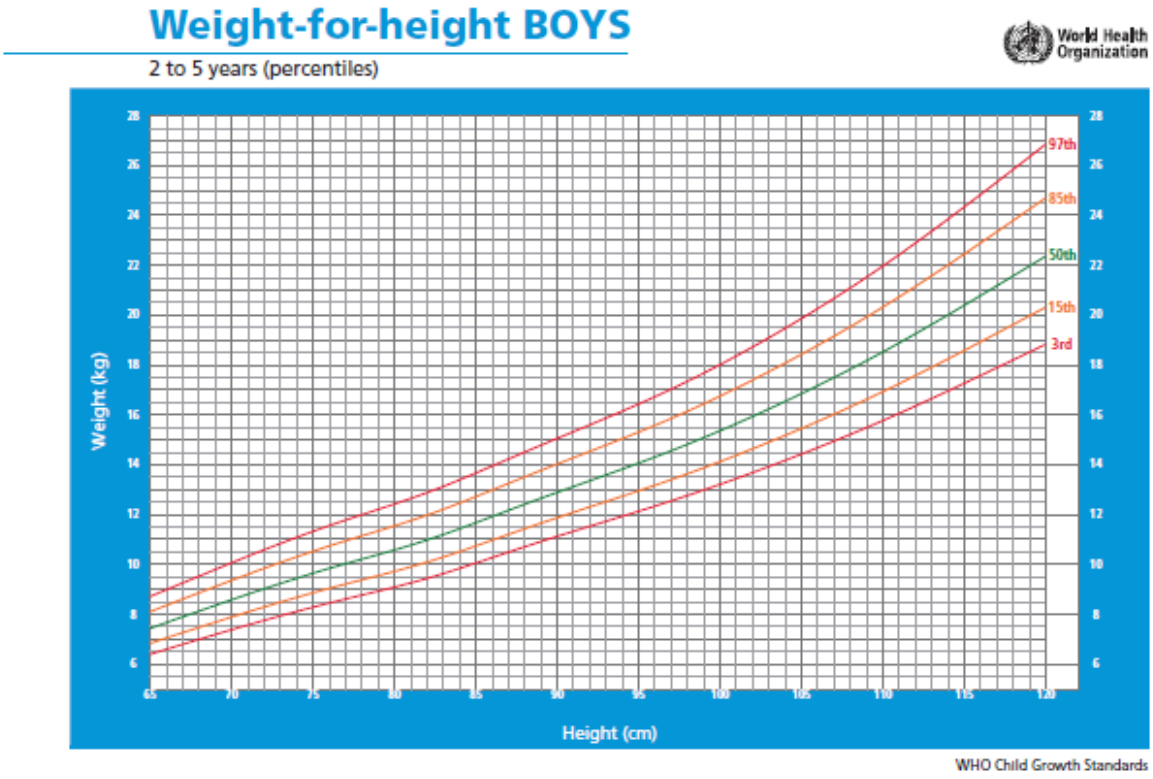



Figure 4. Weight for Height of boys at the age of 2 to 5 years (percentiles)

## Related Research

By 2022, more children and adolescents will suffer from obesity than from underweight.
Over the past four decades, the world has become ten times more children and adolescents (from five to 19 years old) suffering from obesity. If the current trend continues, by 2022 the number of children and adolescents with obesity will exceed the number of their peers with moderately or significantly underweight. Such a conclusion is made in a new study conducted by the Imperial College in London and the World Health Organization (WHO).
The results of the study were published in the journal Lancet on the eve of World Obesity Day (October 11). The study analyzed the body mass and height of almost 130 million people older than five years (31.5 million people aged 5-19 years and 97.4 million - from 20 years and older), this is the largest number of people or participating in an epidemiological study. More than 1000 co-authors contributed to the study, helping to track the values of body mass index (BMI) and the dynamics of obesity throughout the world from 1975 to 2016.
The rates of childhood and adolescent obesity worldwide increased from less than 1% (corresponding to five million girls and six million boys) in 1975 to almost 6% among girls (50 million) and almost 8% among boys (74 million) in 2016 The total number of obese people aged 5–19 years has grown globally more than 10 times, from 11 million in 1975 to 124 million in 2016. Another 213 million in 2016 were overweight, which, however, was less than the threshold value for obesity.

## Spreading Obesity is Promoted by Food Marketing, Policies and Pricing

The lead author of the study, Professor Majid Ezzati from the Imperial College's School of Public Health, said: "Over the past forty years, rates of childhood and adolescent obesity have risen dramatically all over the world, and this process continues in low and middle income countries. More recently, in countries with higher income levels, growth has slowed, although the prevalence of obesity remains unacceptably high. "
"Such disturbing trends are a consequence of food marketing and policy around the world when healthy and nutritious foods are too expensive for poor families and communities. As a result of this dynamic, a generation of obese children and adolescents who are at increased risk of diseases such as diabetes can grow. We need ways to increase the availability of healthy, nutritious food at home and at school, especially among poor families and communities, as well as regulatory measures and tax mechanisms to protect children from unhealthy diets, "adds Professor Ezzati.

By 2022, in the age group of 5–19 years, there will be more obese people than underweight, but the problem of insufficient weight persists in poor regions.

The authors of the study state that, while maintaining the trends observed after 2000, the global number of obese children and adolescents by 2022 will exceed the number of their peers with moderately or significantly reduced body weight. In 2016, there were 75 million girls and 117 million boys worldwide, whose body weight was moderate or well below normal.
However, the presence in 2016 of a large number of moderately or significantly underweight children and adolescents (75 million girls and 117 million boys) is still a serious public health problem, especially in the poorest countries in the world. The situation well demonstrates the danger of malnutrition in all its forms, since young people with both underweight and overweight live in the same places.

In many middle-income countries, including East Asia, Latin America and the Caribbean, the tendency for anomalously low body weight to prevail among children and adolescents has been replaced by a tendency to increase it above the norm. The authors believe that this may be due to the increase in consumption of high-calorie foods, especially carbohydrates, subjected to intensive processing, which leads to weight gain and long-term negative effects on health during life.
Dr. Fiona Bull, Program Coordinator for the Surveillance and Population Prevention of Noncommunicable Diseases (NCDs) of WHO, notes: “These data illustrate, further evidence and evidence that overweight and obesity nowadays represent is a global health crisis that can only get worse in the coming years if we don’t take decisive action. ”

**Survey Data analysis**

During the primary analysis and literature review, decided to perform local survey in Almaty for over 1000 families, with children under 5 years old.
The option identified as best meeting the multiple aims of sample representation, data quality, timeliness, and cost is to conduct the 5 years old children weight through use of supplemental questions following the Survey for those sample persons identified as meeting or having 5 year old children in the families. People have been asked about the average family income, area of living, quantity of people living together, frequency of meals and the quality of food contributed by children. Given potential issues with the problems of children obesity asked from respondents associated children height and weight. The team of IITU data processing course students and mentors have performed the research on survey questions and plan to increase the quality of output data.
According to research results, the plan of survey have been designed and tested. For the test of the survey several groups of people who differs according to age, salary, martial and family statuses were chosen. Overall the 50 people took action during the survey test phase. The results of it is attached.

According to diagram 1, the most dangerous area for children obesity due to inactive way of life are the families where average parents or responsible person age is between 25-30 years and 45-50 years. The data shows that these groups of people are less inclined to provide enough activity for their children or dependents.

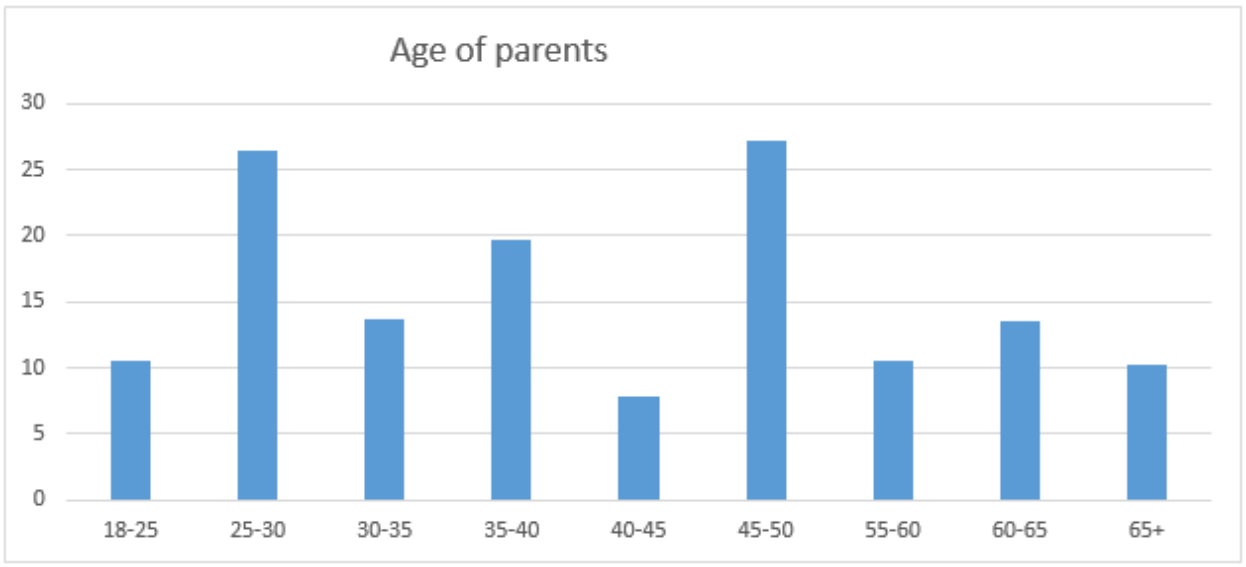


Diagram 1. Dependency of the age of parents on frequency of children’s active time

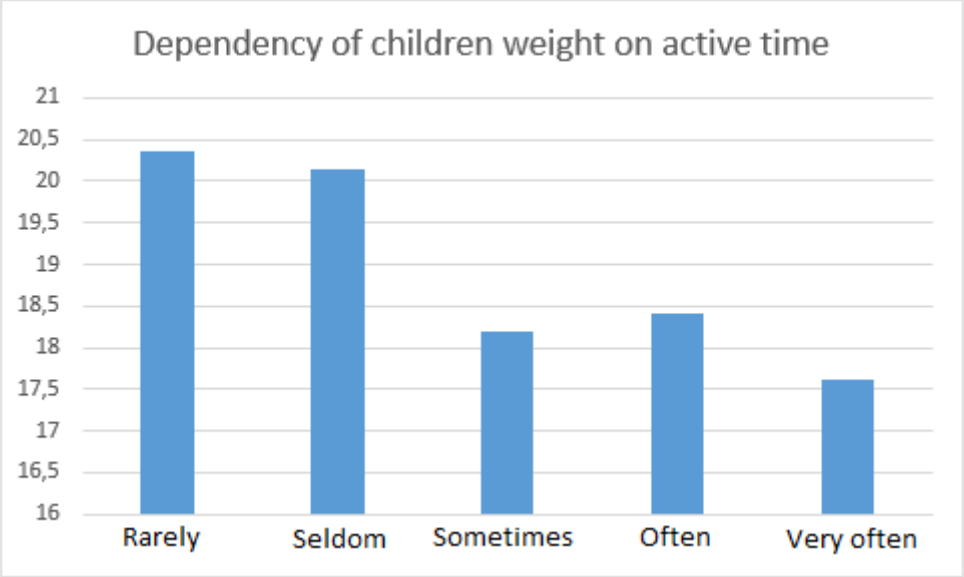



Diagram 2. Dependency of children weighton active time

Diagram 2 displays that the children with less active hours spend are more vulnerable to have overweight problems. Weather at least usual activity fewer the possibility of it.
Hereinafter, we can see that most of children with lower activity rate are already have overweight and obesity problems, weather other children are in the range of normal weight.

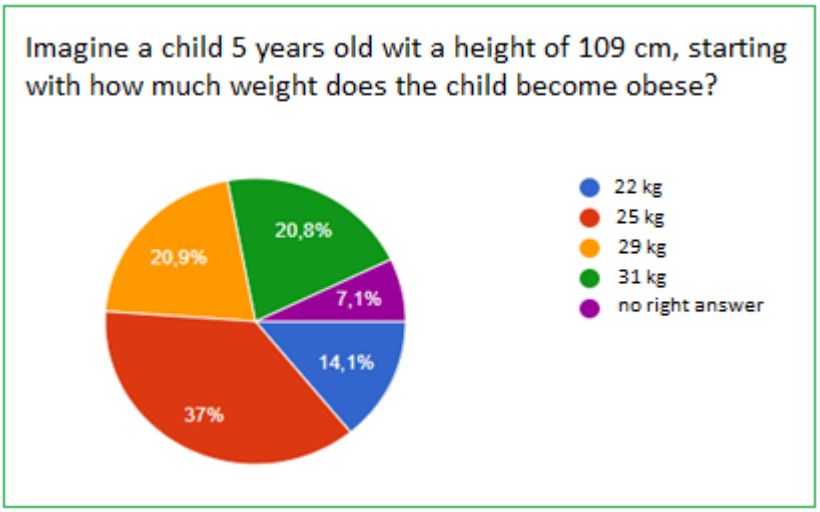



Diagram 3. The test for people about knowledge about overweight and obesity

On the diagram 3 the distribution of answers for the simulation is shown. The simulation: “Imagine the child of 5 years with height of 109 cm. What is the healthy weight for such child?”. According to health standards, the healthy weight for this height is below 19 kg. From the diagram 3 we know that only 7% of 1526 respondents, could correctly answer for the question. Unfortunately most of respondents think that 25 and higher weight is normal for children, which is already an indicator of overweight and high risk of obesity.

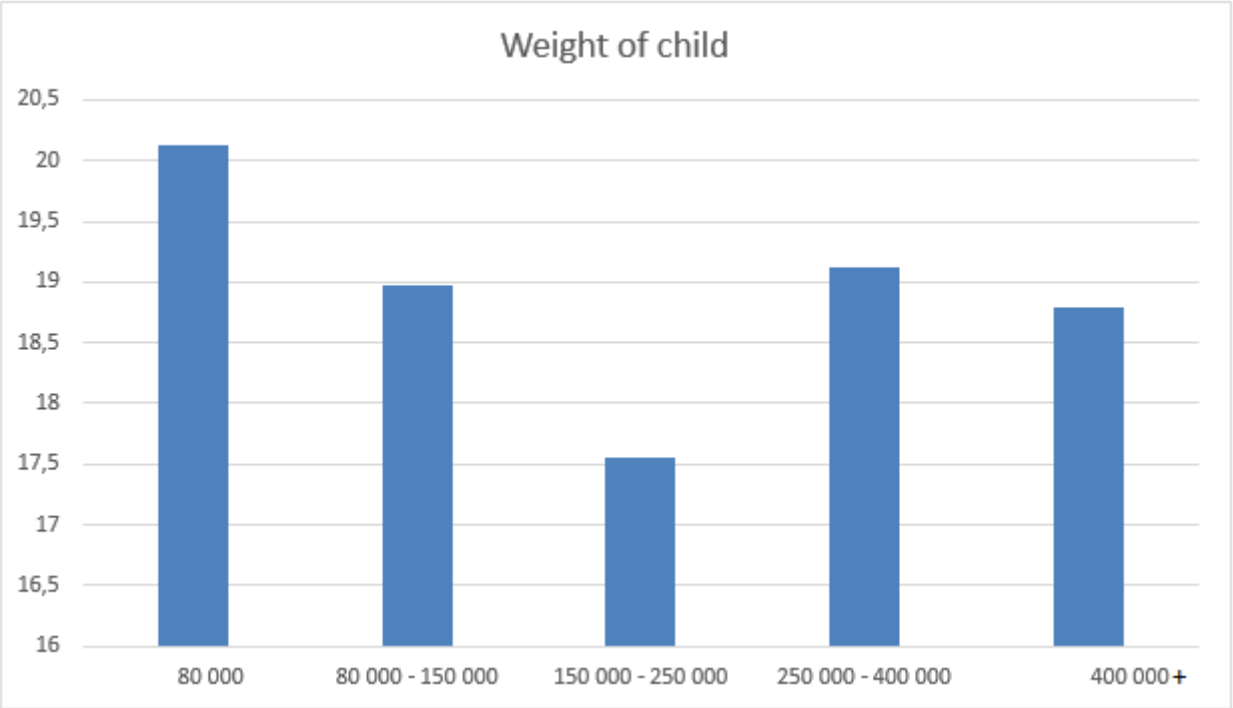


Diagram 4. Dependency of children weightonaverage family income

Diagram 4 present us that the families with monthly income below 80000 are more trendy to have children with overweight symptoms.For the groups whose average monthly income in the range of 80000-150000 tg and 250000 and above, the average weight of children are within the norms of healthy weight. For the families with average monthly income of 150000-250000 tg, children are tend to have less weight in comparison to other groups. This may indicate the possibility of famine in the group, but requires additional investigation.

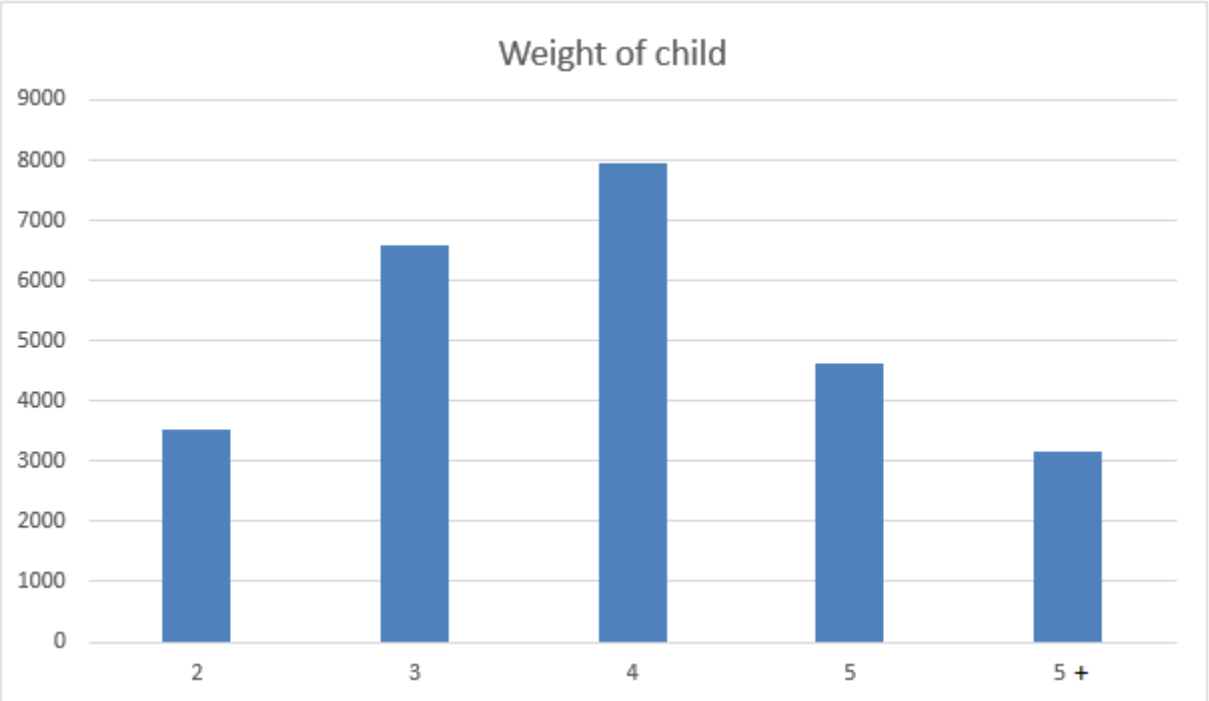


Diagram 5. Dependency of children weightonfamily compound

On the diagram 5 the dependency of children weighton the quantity of family members are shown. According to the chart, the healthy weight observes in the groups, which have from three to five persons including child / children. From the diagram 5 we can see that the average child weight in families with 2 and more 5 family members are having overweight problems and indicators of obesity.

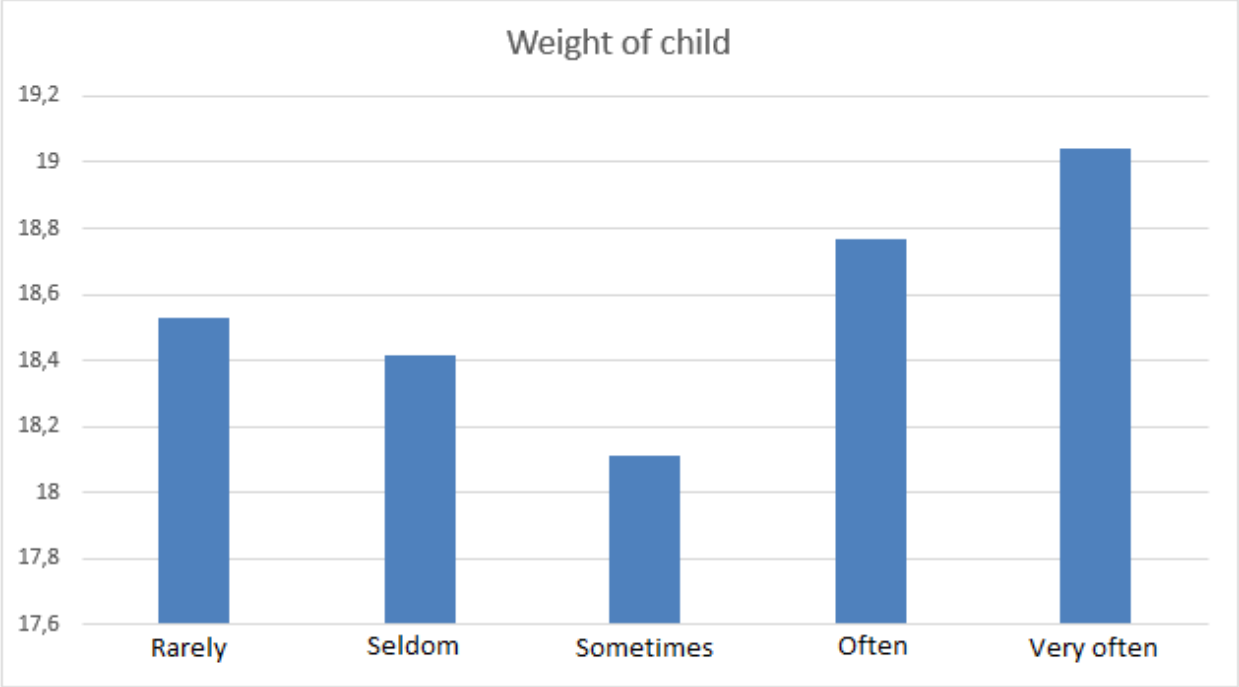



Diagram 6. Dependency of children weightonfrequency of snacks

Diagram 6 displays that the children who tend to have more frequent snack are more predisposition to have overweight and obesity. Children who used to have snack with middle frequency have less weight in comparison with the children who are not having snacks at all.

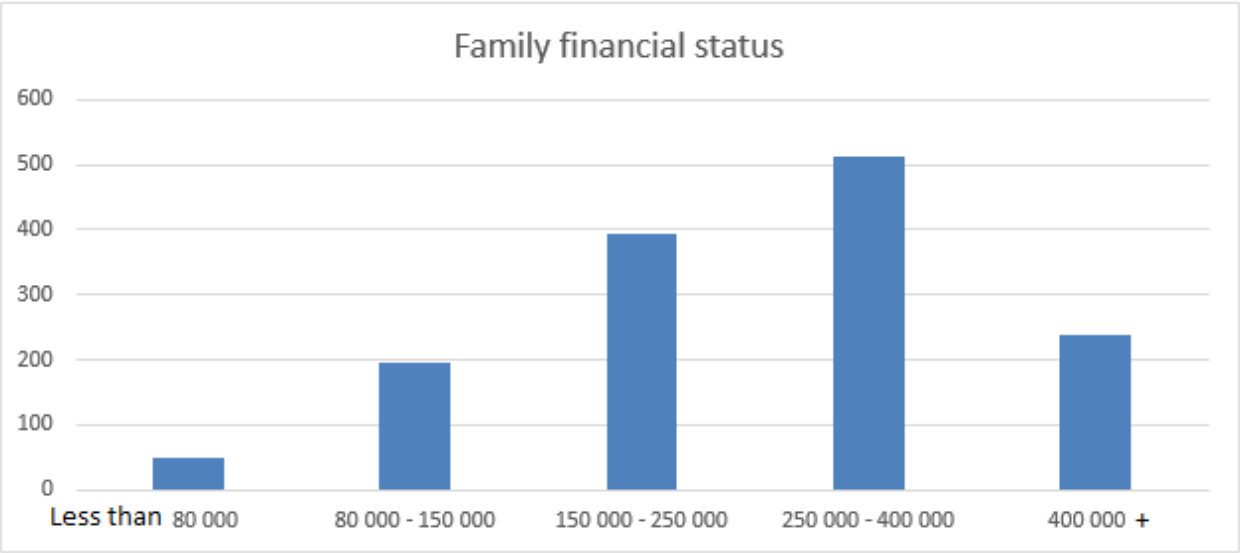



Diagram 7. Financial situation of families

Diagram 7 displays that the quantity of children living in families with different financial situation. Diagram 4 tells us that the most vulnerable families were the ones with average income below 150000 tg. Current chart gives us information that those groups consist of approximately 250 children with the risk of overweight and obesity.

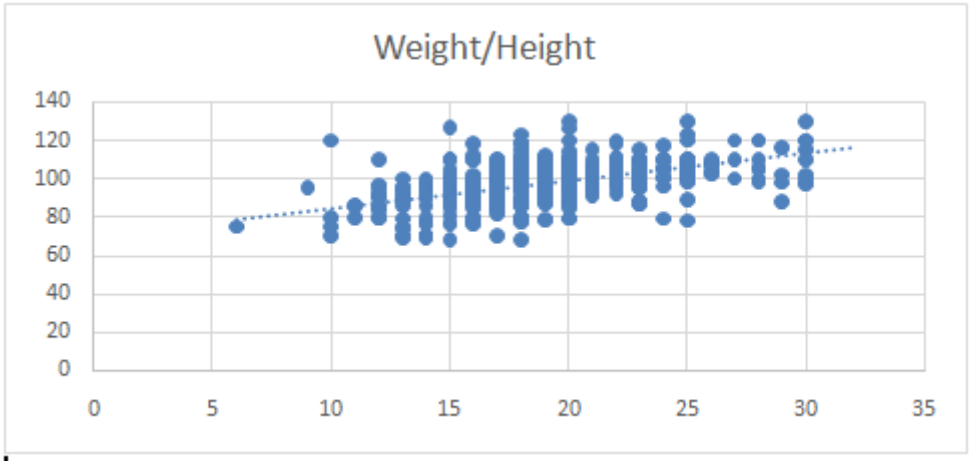



Diagram 8. Children weight and height distribution

**Project 'HealthAdvisor"**

In the first step of our technological solution, we developed an android application that based on weight and height of children determines a trend of body mass index and predict addiction to obesity.

Our first task was creating mathematical model of body mass index trend depending on observed mass and height. There, we explore dependence of relation of mass to height on time.

If we consider m as body mass, h as height

$$BMI = \frac{h}{m^2} \qquad (1)$$

OX axis shows the change of time, OY axis shows the BMI change.

Change of time is found by formula (2)

$$\Delta x = x_2 - x_1 \qquad (2)$$

Change of BMI is found by formula (3)

$$\Delta y = y_2 - y_1 \qquad (3)$$

Our goal is to find relation of $\Delta y$ to $\Delta x$. Thus, formula (4) shows speed of change in BMI.

$$V = \frac{\Delta y}{\Delta x} \qquad (4)$$

If we measure body mass and high several time, then change of BMI on average can be found by formula (5)

$$V_{avg}(n) = \frac{\sum_{i=0}^{n} V(i)}{n} \qquad (5)$$

Where, n is number of measuring.

Figure 5 illustrates a computer realization of body mass index prediction based on previous measures of weight and height. In the figure on the basis on 9 measuring next body mass index is predicted in case of same life style of observed person.

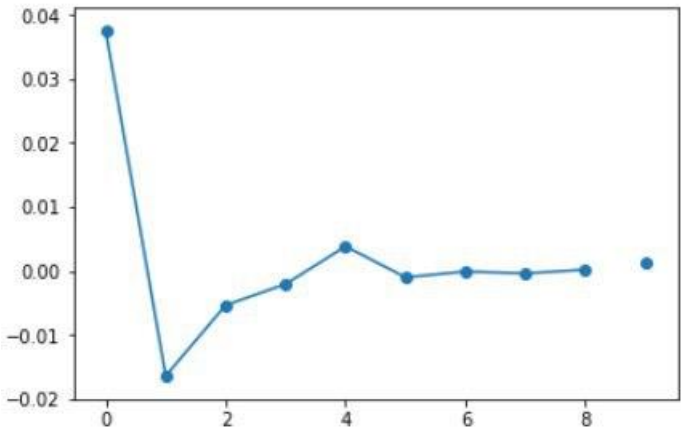



Figure 5. Body mass index prediction

The program reads weight and height data from .csv file. By applying the developed math model, it predicts next point after the fixed period, and returns us the next predicted point (Figure 6).

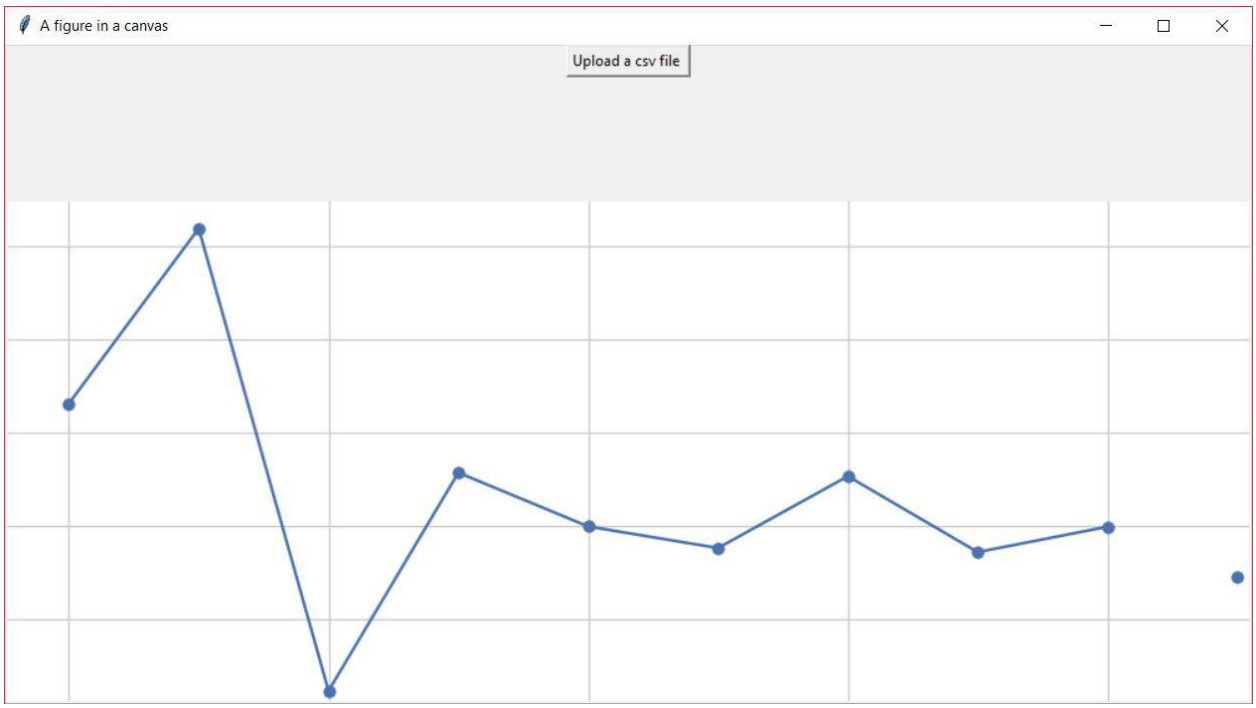



Figure 6. Prediction of next body mass index.

Figure 7-9 illustrate Android application that predict body mass index on the basis on the developed math model. The App demands insert weight and height data (Figure 7), and based on the given data, the app returns a graph that shows BMI tendency and a predicted BMI value (Figure 8). Figure 9 shows the result of expected change of weight, and percentage of weight change.

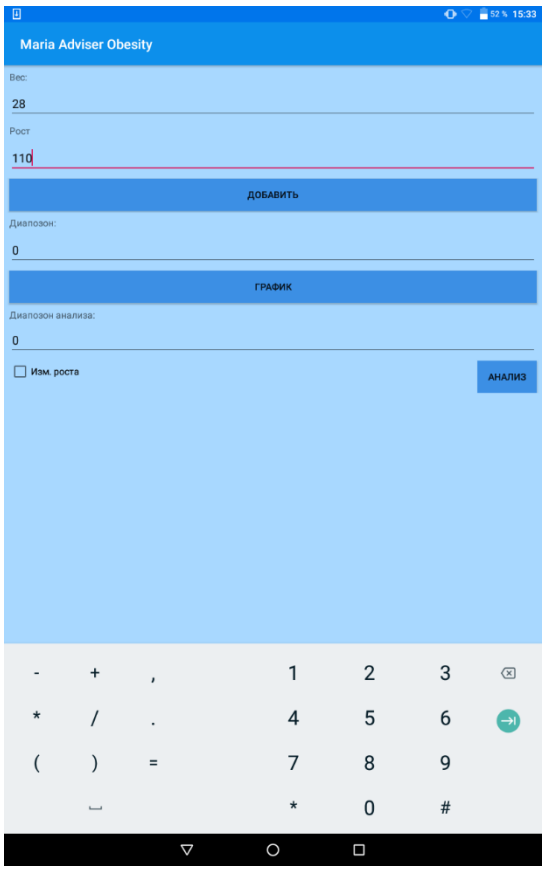



Figure 7. Adding data

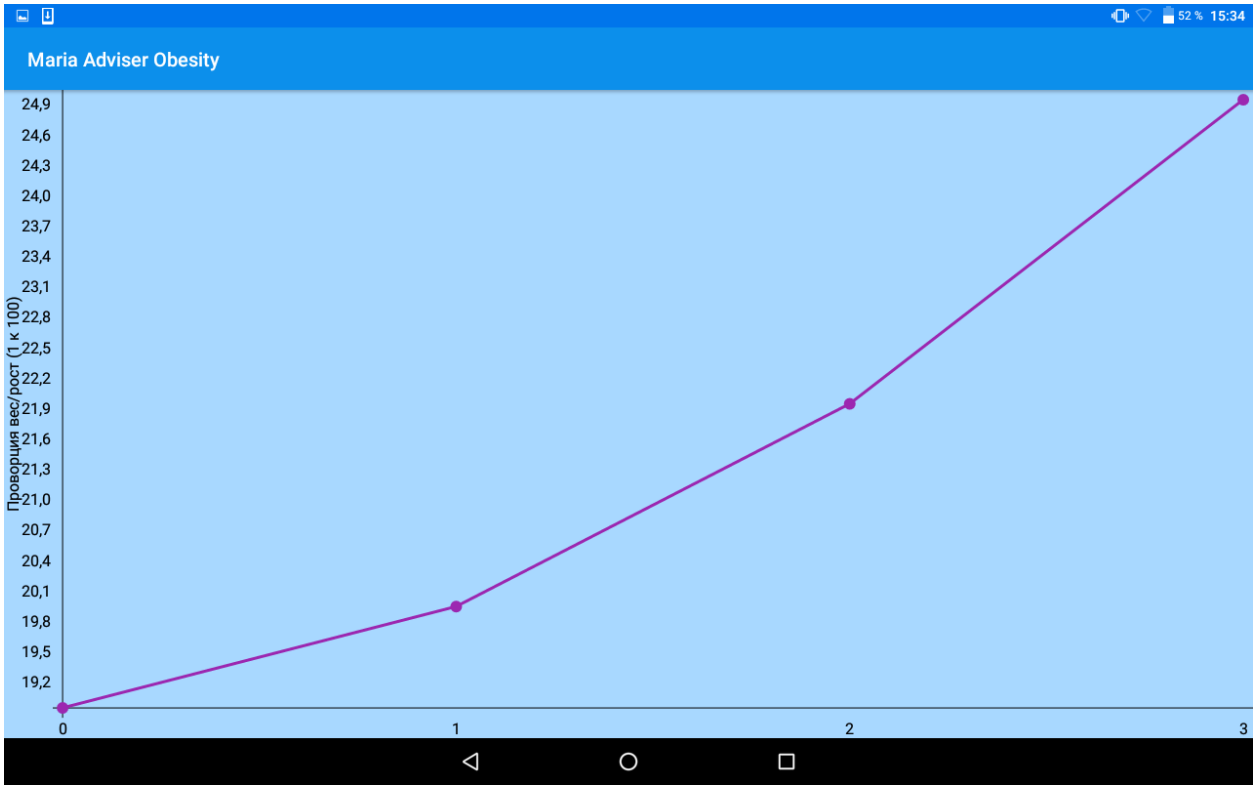



Figure 8. Tendency of Body Mass Index

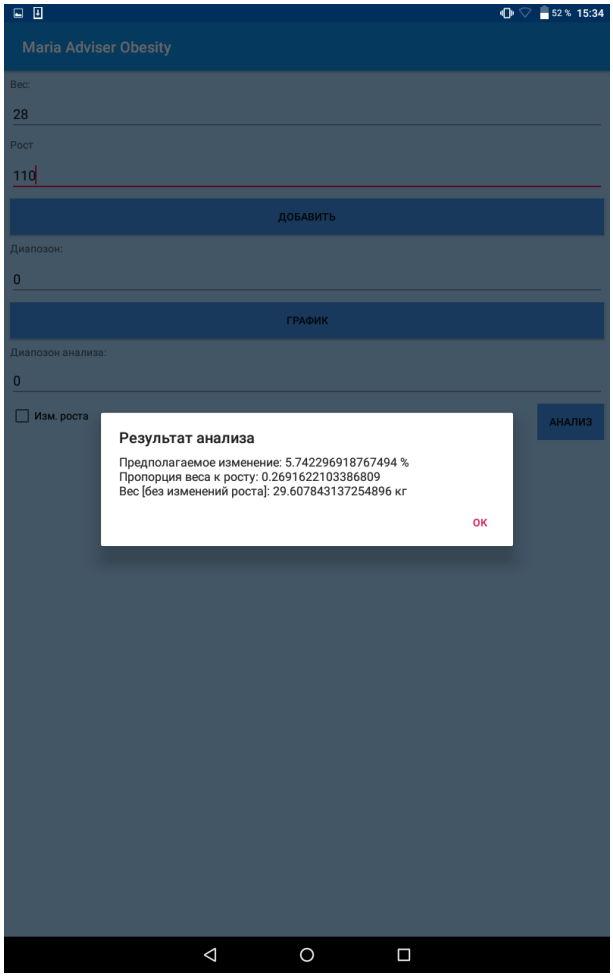



Figure 9. Result of analysis

**Future Plans of "HealthAdvisor"**

Aim: HealthAdvisor will collect and analyze big data on children's behavior and their environment to enable public health authorities plan and execute effective programs against obesity. Main idea of the project was based on BigOprogram – The societal problem of soaring obesity rates in children is being tackled by EU-funded project BigO [9].

Need of multi-level approaches:
Evidence exists that interventions targeting various elements of children's behavioral patterns, like what and how they eat, how they move and how they sleep and environmental community factors, can have a positive outcome against childhood obesity

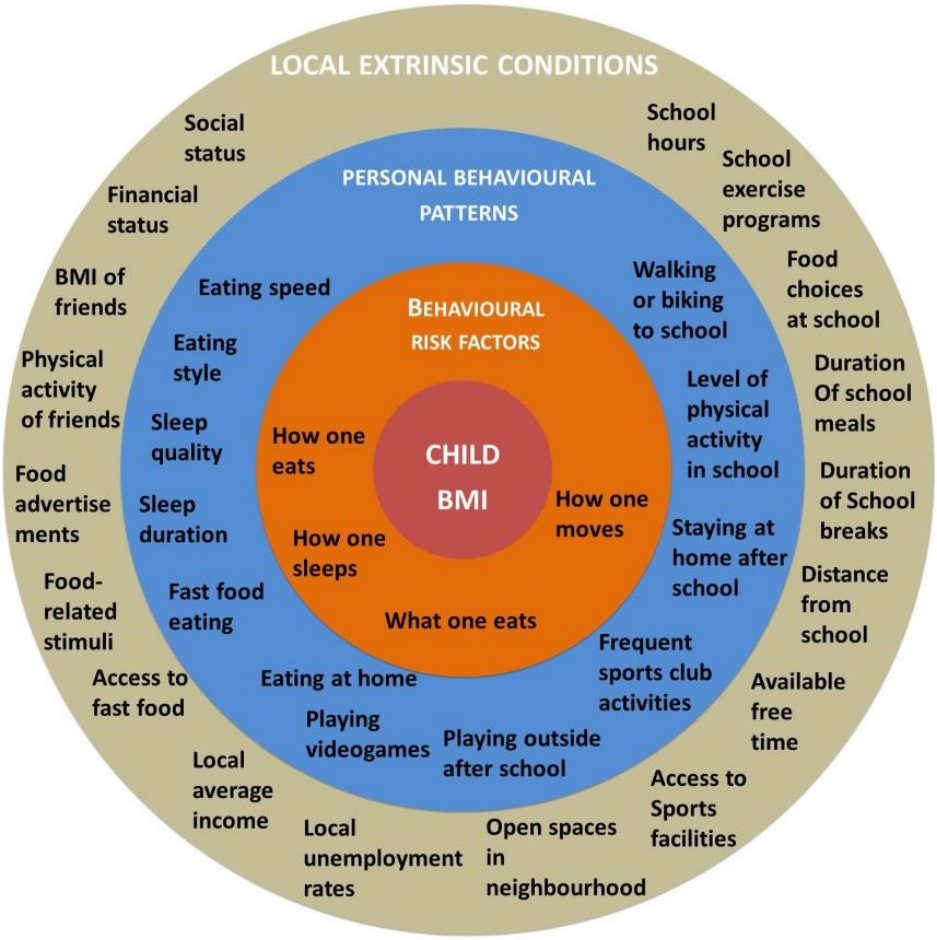
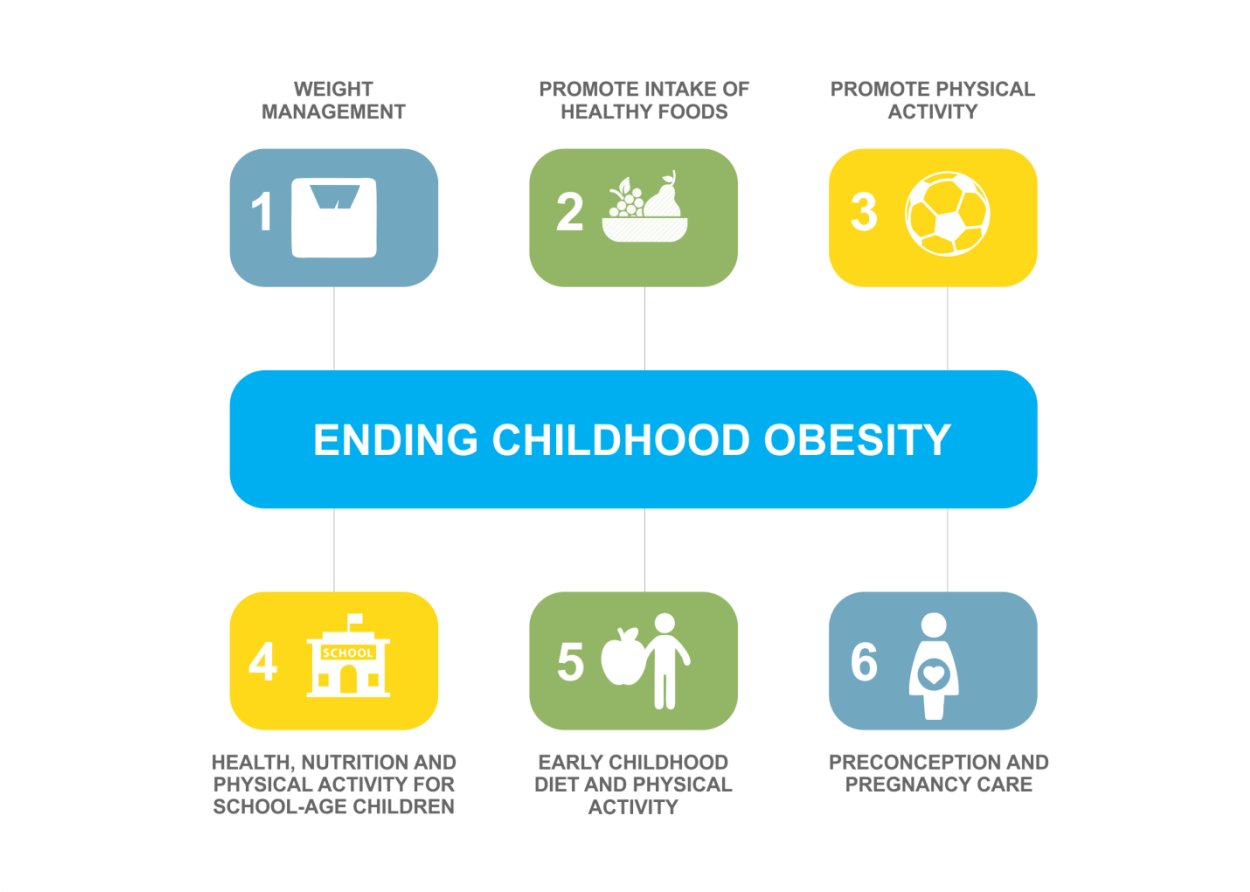



Figure 7. Big data against childhood Obesity [9]

Current Public health actions are not tailored to the needs of local communities, and limited to single element strategies.

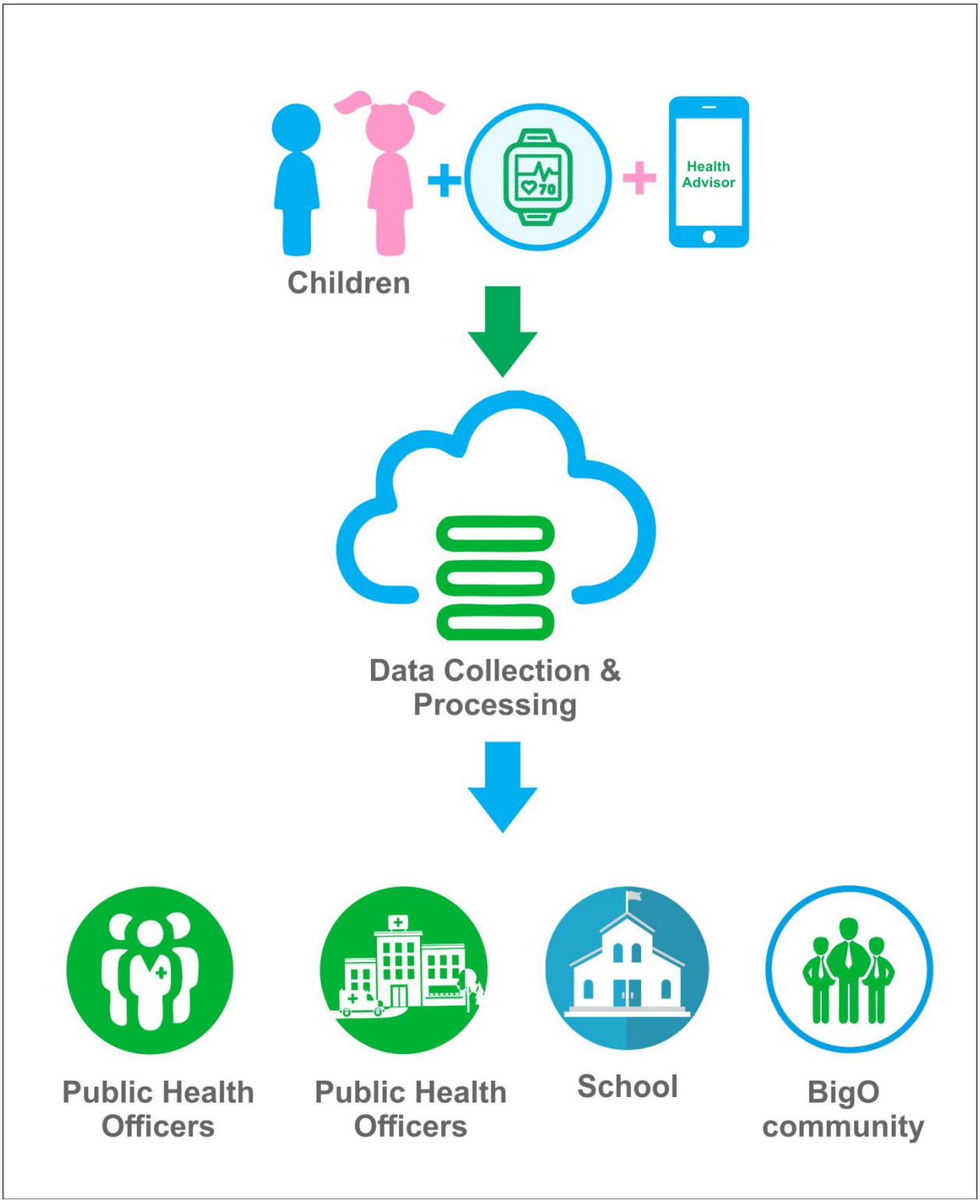



Our Approach:
Exploit sensor technologies and big data analytics to measure obesogenic behavioural patterns and local environment variables, offer evidence and tools for targeted actions against obesity to:

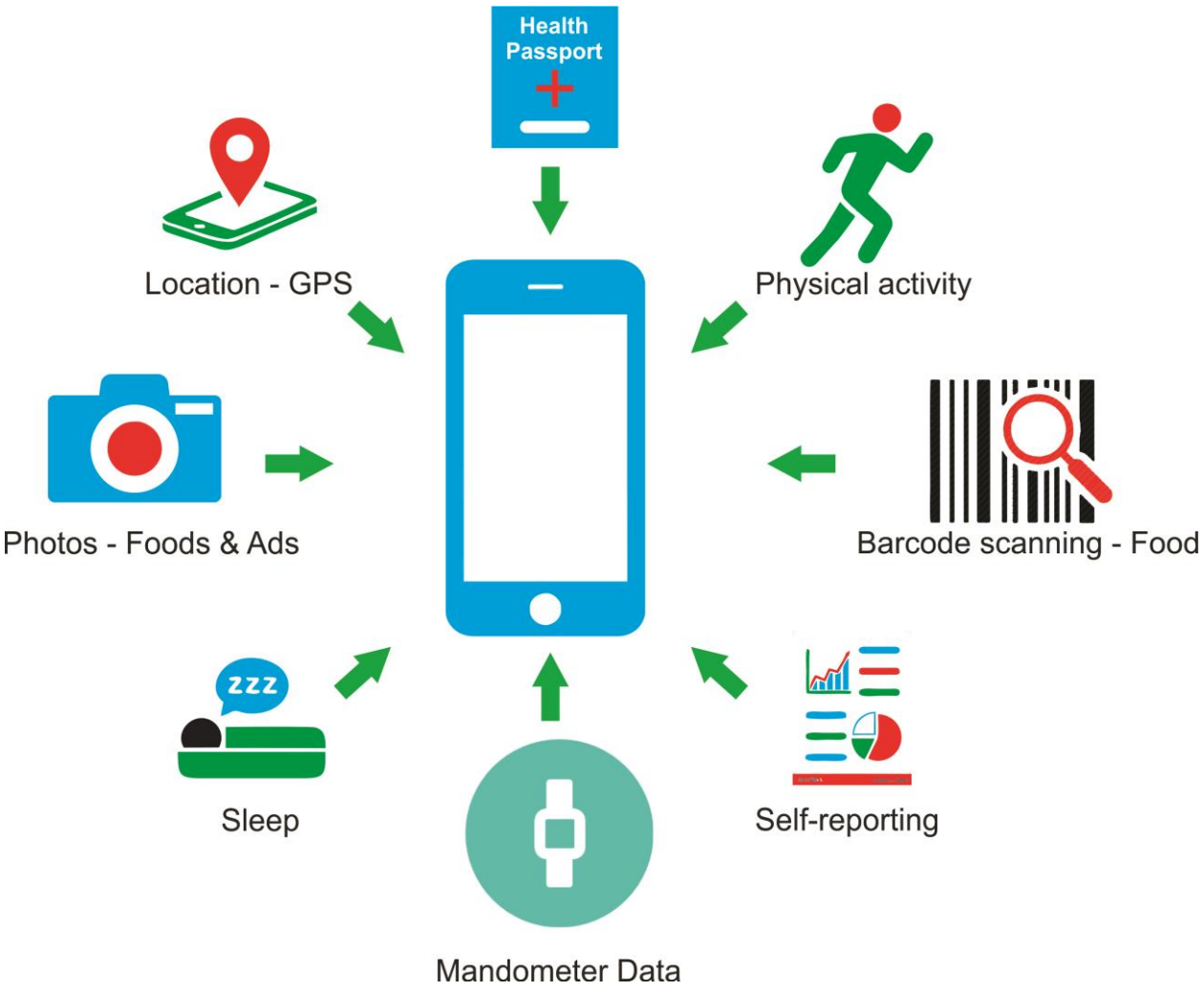
- public health authorities (child polyclinics, polyclinics)
- health professionals
- schools

HealthAdvisor builds a technological platform


Collects behavior and local environment data
Extracts associations between environment, behaviors and obesity
Visualizes aggregated evidence for public health authorities and schools to help them design and monitor programs
Visualizes individual behavioral patterns for health professionals to help them follow-up obese children patients




In this project we measure children's life behaviors as what, where and when they eat; how much, how fast do they eat; how much, where and when they move; how much and when they sleep




Big Data is the key for large-scale evidence covering diversity of behavioural patterns and local environment variables and statistically significant associations

HealthAdvisor is built around the “citizen-scientist” model, which relies on individuals sharing their behaviour data in Kazakhstan.

## Conclusion

Assuming the data provided, collected and analyzed the project gives us information that about 10% of children have overweight and symptoms of obesity. The vast majority of people are not informed about the obesity and children's healthy weight. In addition, we know that about 98% of all population above 20 years have access to the internet, social networks and actively use them. Using regression model to predict weather the average weight would normalize if parents or responsible person would know the information provided, with 87% accuracy the children's average weight would lessen.

Concluding above information, we could provide the people with the information about children obesity and the ways to treat it and prevent using social networks and the internet.

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