Development of computational information technology for monitoring NCD risks in the Russian population: preliminary results

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Abstract. Here, we report first results on the development of computational health information technology for monitoring chronic non-communicable diseases (NCDs) risks in Russia based on data of the large-scale ongoing population survey in Health Centers (HCs). The technology involve algorithms for automated raw data process and generation of joint database, tools for data standardization and visualization, the assessment of risks, and other components. The data on physical status of Russians, including height, weight, and BMI are provided and compared with Belgian (1835), Swiss (2002), and US (1988-1994) reference datasets. The age-standardized prevalence of obesity in 5-85 years-old Russians according to the conventional WHO criteria was found to be high (18.9\% in males and 26.7\% in females) and varied significantly across federal subjects of Russia thus suggesting an importance of the Russian NCDs risks monitoring system for planning and evaluation of the effectiveness of preventive and therapeutic measures.

Keywords. Computational health informatics, non-communicable disease risks, large database, data processing and standardization, physical status, anthropometry

Introduction

The current epidemiological situation in Russia and other countries is characterized by high rates of morbidity and mortality from chronic non-communicable diseases (NCDs) and a tendency to increase their role in the overall mortality thus entailing significant socio-economic losses [1-3]. The mortality from NCDs in Russia exceeds that in EU countries by a factor of 3-10 in all age groups, including the most productive age, and is estimated to be accounted for 80-82\% of all deaths. Accurate data are vital to reverse the rise in death and disability from NCDs [4]. The large-scale population-based survey in Russian Health Centers (HCs) that was initiated at the end of 2009 and now continues has a potential to become a reliable and powerful source of data for monitoring NCDs risks. At present, the methods routinely used in HCs include anthropometry, bioimpedance analysis, cardiovascular and angiologic screening,

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spirometry, blood pressure, lipids and glucose assessment, and other. Malnutrition and inadequate physical activity are among major modifiable risk factors of NCDs. These are associated with the parameters of physical status, such as height, weight, body mass index (BMI) and other [5]. Up to now there has been a lack of Russian anthropometric data enabling calculation of standardized values of diseases prevalence and the assessment of risks (see, e.g., [6]). Our aim was to describe a framework of computational health information technology for monitoring NCD risks in Russia and to present initial results of its application to study physical status of the Russian population based on data of the above-mentioned survey.

1. Materials and methods

We used ‘anthropometric’ part of a set of 2010-2012 bioimpedance data from 819,808 clinically healthy Russians aged 5-97 years representing 0.6% of the total population of Russia. The measurements were collected from 220 HCs in 52 out of total number of 83 federal subjects of Russia. Females visited HCs nearly twice as often as males thus indicating more women’s attention to their health and commitment to a healthy lifestyle (Fig. 1). The observed peaks of attendance reflect a focus of the survey on the school age (7-17 years) and rise of NCD morbidity at the age interval 50-75 years. (The minima at 68-70 years of age correspond to low birthrate during the WW2.)

![Figure 1. The percentage coverage of the Russian population in our study according to age.](image)

Height and weight were obtained using automated anthropometric measurement system to the nearest 0.1 cm and 0.1 kg, respectively. BMI was calculated as body mass (kg) divided by height (m) squared. The centile curves for height, weight and BMI were constructed using the Box-Cox t distribution [7], similar to the LMS method of Cole and Green [8]. Calculations were done in MS Excel with an add-in RExcel using an original R macros and software package GAMLSS [9]. For comparison, we used a historical [10] and contemporary [11-13] datasets from various countries.

2. Results and discussion

Essential parts of the computational technology for monitoring NCDs risks will be: automated procedure for gathering and assembling data from HCs; development and application of inclusion/exclusion criteria (data filtration); data compression (in the form of centile reference tables and the parameters of respective distributions for variables under study); application of existing criteria for NCDs risks estimation,
automatic selection of high risk groups; algorithms for data standardization (using demographic and other data) and visualization. Partial realization of the technology enabled us to obtain the results which are presented below. Fig. 2 shows international comparisons of body mass medians according to age. It can be seen that at the age interval 5-25 years, the medians of body mass in Russians (also true for body height) strictly follow the updated ICRP data on reference man [11]. The respective differences ranged between 0.1 and 1.6 kg in body mass, and 0.1-1.2 cm in body height. Residents of Brussels measured by A. Quetelet in the first half of the 19th century [10] were significantly shorter on average and had a significantly lower weight as compared to modern humans. The mean intergroup differences between Russian and Belgian children aged 5 were 11 cm for height and 3 kg for body mass.

Figure 2. Median values of body mass in Russian males and females: international comparisons.

As compared to our subjects, US adolescent and adult males had an increased [13], and Swiss men and women – a decreased [12] values of body mass (Fig. 2). We observed similar patterns of median body height changes with age in Russian, Swiss and US populations (data not shown). In older age groups, the median height of Swiss and US adults was slightly higher than in our sample. The intergroup differences in BMI (Fig. 3) were generally consistent with those observed for body mass. Interestingly, the median values of BMI in modern population of 20-60 years-old Swiss women [12] were similar to those of the 19th century Belgian women [10] being within the normal range according to WHO classification. According to NHANES III data on US non-Hispanic whites, more than half of men and women over the age of 25 and 34 years, respectively, were overweight [13]. In Russians, the 50% threshold for overweight was overpassed at the age 31 years for males and 39 years for females (Fig. 3). The age-standardized prevalences of overweight and obesity in Russians are shown in Table 1. More details on the bioimpedance screening in Health Centers can be found in our dedicated book [14].

Figure 3. Median values of BMI for Russian, USA (NHANES III, 1988-1994), Swiss (Schutz et al., 2002), and Belgian (Quetelet, 1835) males and females according to age.
In summary, our results indicate a potential usefulness of data from Health Centers for monitoring NCD risks in the Russian population. Regular collection and analysis of data from Health Centers could become a basis for evaluation the effectiveness of prevention programs and improving management decisions aimed at reducing morbidity and mortality from NCDs. Our future research will include program tools for joint processing HCs’ datasets on all the available techniques. This work is supported by the grant from the Russian Scientific Fund for small research teams to Federal Research Institute for Health Care Organization and Informatics of Ministry of Health of the Russian Federation.

References


Table 1. The prevalence of overweight and obesity in Russians according to the conventional WHO criteria

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Overweight, %</th>
<th>Obesity, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>5-17</td>
<td>31.8</td>
<td>25.7</td>
</tr>
<tr>
<td>18-85</td>
<td>56.6</td>
<td>57.8</td>
</tr>
<tr>
<td>5-85</td>
<td>52.9</td>
<td>53.9</td>
</tr>
</tbody>
</table>

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