Original Article

Screening of Cardiovascular Disease in Kazakhstan

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Abstract

Background: Mass screening is an effective way to detect the risk of cardiological diseases early. Still, the main problems during mass screening are the availability of screening methods and the efficiency of disease intelligence with a minimum expenditure of time.

Method of dispersive ECG charting proves to be the most effective from the point of sensitivity to metabolic changes in the Myocardium of any origin (it provides a 95 % probability of detection of heart disease at an early stage) among non-invasive, easy-to-use methods of control accessible for broad clinical practice. This method also provides unique information unobtainable by other methods in real-time regarding transient functional disorders that are precursors of pathology.

Objective: The purpose of the study was to examine the dispersive ECG charting indexes related to various factors of risk of cardiovascular disorders among the rural population of the southern region of Kazakhstan.

Method: We screened 500 rural residents of the Zhambyl Region of Kazakhstan to assess the state of the cardiovascular system. 12 standard derivations and the dispersive ECG data were recorded using the Heart Screening System “CardioVisor 12C”. The “Statistika 7” program processed statistical data.

Results: We observed the depreciation of the Myocardium’s compensatory mechanisms, violations of the Myocardium’s electrophysiological properties, and autonomic dysfunction in heart rate with age.

Conclusion: The study revealed the highest percentage of changes in the cardiovascular system in virtually healthy people aged 40-49, which might indicate the need for a dynamic monitoring of health and timely preventive measures.

Keywords: cardiological screening, CardioVisor, cardiovascular disease, ECG dispersive charting, risk factors for cardiovascular disorders, screening of rural population.

Introduction

The problem of early detection of the risk of socially significant cardiovascular diseases is of high practical significance and importance worldwide. Heart diseases often appear suddenly in humans who feel well before such episodes.

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Modern screening technologies are necessary to promptly identify people at high risk of cardiovascular diseases during mass preventive examinations.

Previously used cardiological screening methods included questioning, a cardiologist's examination, and electrocardiogram registration (ECG). Now the screening also includes additional laboratory and instrumental tests, one of them being the dispersive ECG charting. This method plays a vital role in cardiological screening as, during several years of testing, it has proved to be the most sensitive to metabolic changes of any origin in the Myocardium (it provides a 95% probability of early detection of heart disease) among non-invasive, easy to use methods of control accessible for broad clinical practice.1,2,3 Moreover, this method provides unique information regarding transient functional disorders as precursors of a pathology unobtainable by other methods in real-time.4,5

The article contains the results of cardiological screening done based on mobile medical units using dispersive ECG charting for early detection of the risk of cardiovascular disorders among the rural population. The screening aimed to investigate the dependence of dispersive ECG charting indexes on various risk factors of cardiovascular disorders among the rural population of the southern region of Kazakhstan.

Materials and methods

The screening was conducted based on motorized mobile medical units (MMU) among the rural population (500 adults, of them 62% women and 38% men) of Otar and Gvardeysk settlements, Korday District, Zhambyl Region, mean age of 42.6 years (17 to 83 years). Grouping by age: 17 to 29 years – 15.7%; 30 to 39 years – 18.6%; 40 to 49 years – 14%; 50 to 59 years – 7.4%; 60 to 69 years – 4.7%; and >70 years – 2.1%.

Methods included questioning on complaints, life history and anamnesis; physical examination; and the ECG recorded at rest. CHD was diagnosed in the presence of one or more signs such as exertional angina (pectoris), scarring changes in the Myocardium – in case of pathological Q and QS waves, taking into account the history related to myocardial infarction (MI) in line with the classification adopted in the Republic of Kazakhstan.

Hypertension was diagnosed in the case of systolic blood pressure (BP) ³ 140 mm Hg and/or diastolic BP ³ 90 mm Hg. Standard questionnaires were used to identify behavioural factors of risk of chronic non-communicable diseases.

The height and weight of the examined population were measured to identify overweight. Body mass index (BMI, kg/m^2) was determined in line with a standard procedure by the following formula: body weight (kg)/body surface area (m2).

Biochemical blood tests were carried out in MMUs according to the manufacturer's recommendations (cholesterol and lipoproteins).

The state of the cardiovascular system was evaluated using six-channel electrocardiography based on ECG dispersive charting method, with registration in 12 conventional derivations and data delivered by the heart screening system "CardioVisor 12C" with "KARDi-2" software.

Cardiological screening also included ECG dispersive charting – a fairly new method of early detection of disorders of electrophysiological properties of Myocardium through micro-alternations of cardiac cycle not detectable by conventional ECG.

This method is based on forming an informational and topological model of small ECG oscillations – electrical micro-alternations of ECG signal. Reasons for such micro-alternations can be the disorders of ion transport function, cell membrane structure and mitochondrial energy production, as well as microcirculatory disorders and others. Deviations in different electrophysiological characteristics in various pathological processes change the amplitude of micro-alternations. The nature and degree of change of micro-alternations is a new set of diagnostic signs reflecting the "stock" of electrophysiological compensatory resources of the Myocardium.1,6 This new method is now used in clinical cardiology to identify the Myocardium's adaptive responses and early disorders of electrophysiological properties as useful diagnostic markers for approaching structural changes. The numerical expression of variance analysis of low-amplitude oscillations of time slots of the PQRST complex is reflected in the integral index "Myocardium". The index of the Myocardium integrally reflects the total amount of dispersion deviations from the norm. It is interpreted as the degree of exchange-energy and ischemic changes in the heart muscle that do not appear on the electrocardiogram but pose the risk of heart disease.

Values of "Myocardium" <15% are typical, values from 15 to 27% indicate the probability of heart disease and the need for a comprehensive differential diagnostic examination; values >27% reflect pathological disorders in the heart and the need for a thorough, in-depth survey.

Heart Rate Variability (HRV) as an indicator of the tone of the autonomic nervous system was measured as an additional component of screening using "CardioVisor 12C" device based on the methodology of calculating the total activity of cardiac rhythm regulatory systems by P.M. Bayevsky. "CardioVisor 12C" shows the simplified dynamic integral component of HRV. In the case of optimal balance between the sympathetic and parasympathetic influences on the heart rate, the HRV is between 0 and 20 %; in the case of any vegetative dysfunction, it exceeds 20 %.1,4,6

"Statistika 7" software was used for statistical data processing that included calculating descriptive statistics values, calculating the distribution of individual traits and evaluating its key features. The significance of differences in mean values for the entire set of research was assessed using nonparametric criteria Wilcoxon, U-criteria of Mann-Whitney, at a significance level of 95% ($p < .05$). The Ethics Committee approved the study design of the Kazakh-Russian Medical University.

Results and discussion

The analysis of the integral index of the Myocardium showed that 65.26 % of the population had the standard (>15 %) value of the integral index of the Myocardium, which evidenced the absence of heart pathology. 25.8 % of the rural population had sub-threshold violations of the heart (Myocardium – from 15 to 27 %), and almost 9 % of the population had signs of pathology (Myocardium >27 %).

The examined rural population was grouped by age: Group 1, aged >40 years; Group 2, aged 40 to 49 years; and Group 3, aged □50 years. We observed the highest percentage of changes in the index of the Myocardium to borderline states between normal and deviations – 30.4 % (Table 1) in the group of practically healthy persons aged 40 to 49 years.

Table 1. Index of Myocardium by age groups

Age groups, years	Norm, %	Borderline state, %	Deviations, %
>40	63.1	28.3	8.6
40 to 49	63.0	30.4	6.6
≥ 50	74.2	12.9	12.9
Total	66.8	23.9	9.3

We found that the index of the Myocardium increased with age, with a significant correlation at the level of .05. Index of the Myocardium varied statistically significantly in different age groups: 15.5 %, $p \leq .02$ in Group 1, and 18.9 %, $p \leq .02$ in the Group 3 (Fig. 1).

Effect: F(2, 233)=5.64, p=.004

Vertical lines 95% confidence intervals

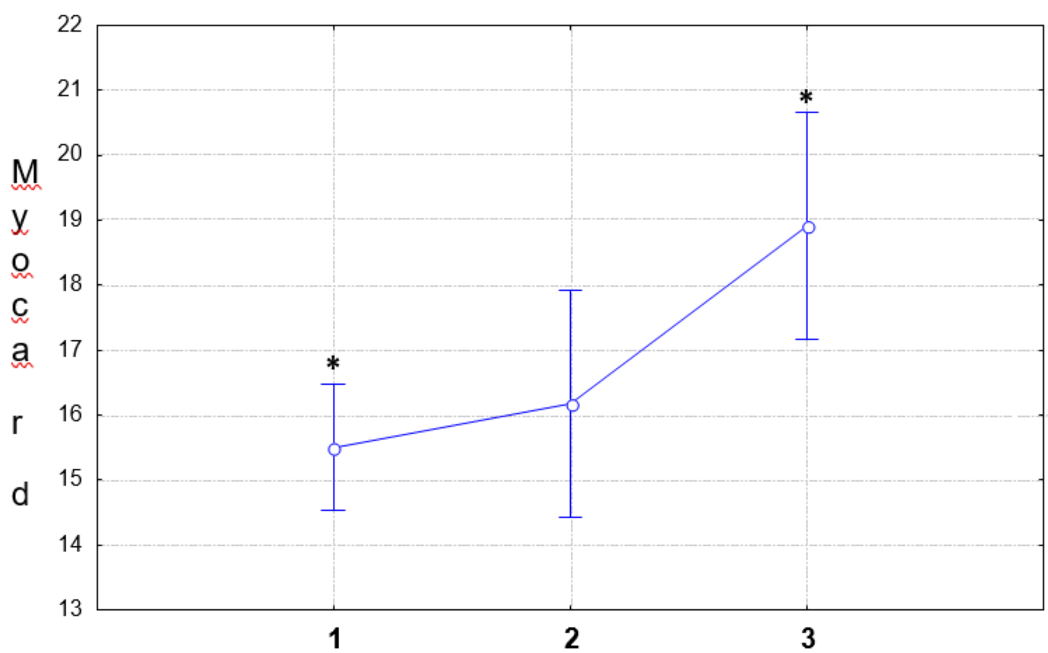

Figure 1. Mean values and confidence intervals of 95 % of the index of Myocardium in the three age groups

* - statistically significant differences in the index of the Myocardium, p = .004.

The index of the Myocardium was linearly related to the detailing indexes G7 and G9 ($p < .01$), which reflected the symmetry of ventricular depolarization and the compensatory response of the left ventricle, respectively. G9 was regarded as the most dynamic indicator of compensatory mechanisms of the left ventricle in ECG dispersion charting. According to that indicator, the small values of G9 < 5 might be due to individual myocardium peculiarities, while G9 > 5 predicted hidden abnormalities. The revealed a statistically significant difference between the G9 values in patients without CHD (2.84 ± 4.78), and with CHD (7.67 ± 8.80), p = .03 (Fig. 2) reinforced the statement made. We also observed that the incidence of CHD among the examined rural population was 7.5 %, which included 3.2 % of men and 9.0 % of women.

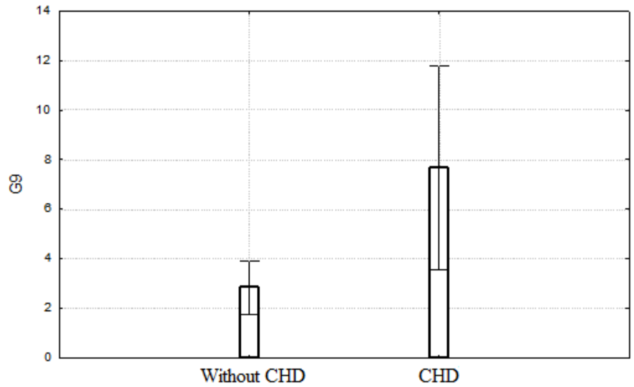

Fig.2. Mean values of G9 in the presence and absence of coronary heart disease. Vertical bars - 95% confidence intervals

Vertical segments: confidence intervals of 95 %

Figure 2. Average values of G9 with coronary heart disease (CHD) and without CHD

Certain representative indicators of ECG dispersion charting that reflected insufficient oxygenation of the myocardium or myocardium perfusion abnormalities were analyzed to detect hidden abnormalities. The analysis showed the statistically significant increase of those indicators (Fig.3) among practically healthy elderly people: G3 (p = .04), G6 (p = .008), G7 (p = .0002). The factor of Age had a statistically significant effect on the parameters: G3 (p = .04), G6 (p = .008), G7 (p = .0002). It might indicate the depreciation of compensatory mechanisms of ventricular Myocardium with age and the presence of hidden abnormalities. So, the mentioned changes reflected the age-related decline of compensatory reactions and the early stages of violations of electrophysiological properties of the Myocardium, i.e., markers of forthcoming structural changes.6

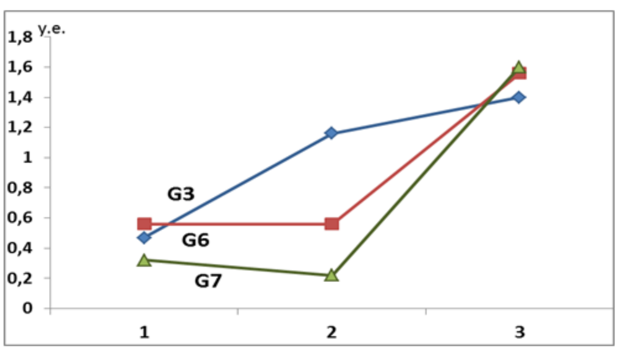

Fig.3. Mean values and 95% confidence intervals of parameters G3, G6, and G7 in 3 age groups. Note: the "Age" factor has a statistically significant effect on the parameters: G3 (p=0.04), G6 (p=0.008), G7 (p=0.0002).

Figure 3. Mean values and confidence intervals of 95 % for the parameters G3, G6, and G7 in three age groups.

Analysis by gender showed a statistically significantly ($p < .05$) correlation of Myocardium index with HRV in women – 0.22, as opposed to men. Differentia in Myocardium and HRV indexes in men and women without verified cardiovascular disorders revealed statistically significant differences from a comparative perspective (Table 2).

Table 2. Differentia in Myocardium and Heart Rate Variability (HRV) indexes in men and women without verified cardiovascular disorders

Index	Men, M±δ	Women, M±δ	Level of statistical significance, p
Myocardium	15.1±4.7	16.8±6.7	0.04
HRV	26.4±22.5	38.7±22.8	< 0.001

Such changes could be due to a more robust sympathoadrenal activation in women since more women with a positive correlation of Myocardium and HRV indexes had hypertension (33.1 % of the observed women, as opposed to 22.4 % in men). At that, 8.7 % of women with CHD had hypertension, compared with no hypertension in rural men with CHD.

We observed that all the age groups had autonomic dysfunction of heart rate regulation (the integral index HRV >20 %). The level of statistical significance during pair-wise comparison of values of autonomic regulation of the heart by HRV index in all the three age groups showed statistically significant differences in Group 1 (29.13 %, $p \leq .0008$) and Group 3 (46.38 %, $p \leq .001$). Those changes indicated the higher presence of autonomic dysfunction of heart rate regulation among older people (Fig. 4).

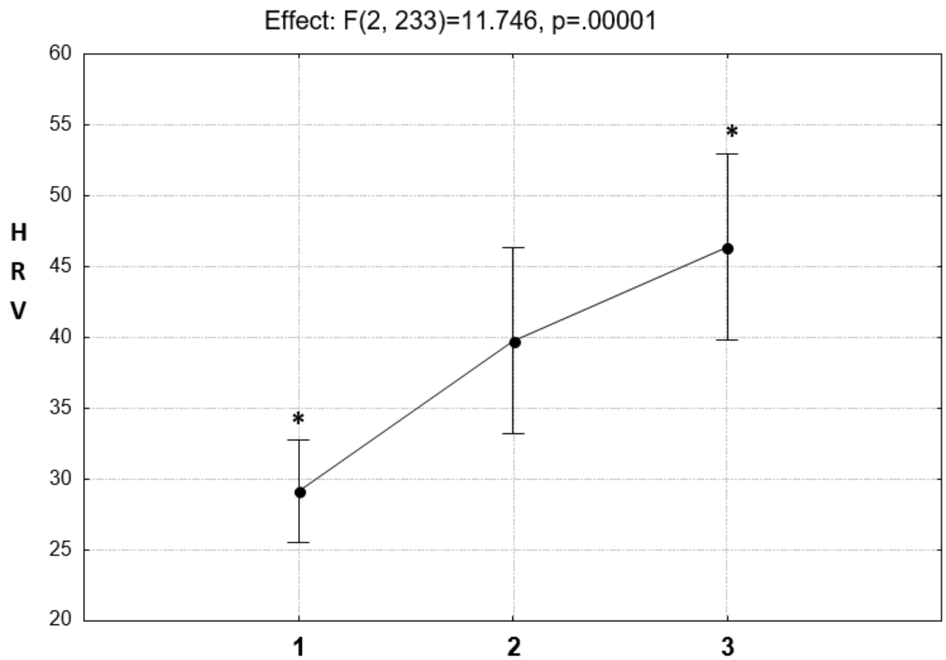

Fig4. Mean values and 95% confidence intervals of the HRV parameter in 3 age groups,
note: * - statistically significant differences in HRV, p=.00001.

Figure 4. Mean values and confidence intervals of 95% of the Heart Rate Variability (HRV) index in the three age groups

The sympathetic and parasympathetic nervous system imbalance may contribute to arrhythmias.7 Also, HRV is one of the predictors of life-threatening arrhythmias and an indicator of myocardial electrical instability8; therefore, the assessment of the tone of the autonomic nervous system is an important additional component of cardiological screening.

Numerous authors say that the main risk factors influencing the development of cardiovascular disease are related to lifestyle and habits: low physical activity, overweight, smoking, psycho-emotional, and other factors. The assessment of behavioural risk factors revealed a relatively low percentage of smokers among the rural population – only 21 %. At that, neither of the participating respondents was abusing alcohol. Changes in the index of the Myocardium did not correlate to the factor of smoking, the level of cholesterol.

The comparative analysis of changes in the Myocardium's integral index and BMI revealed interesting results. The calculations showed that 45.3 % of the rural population (67.5 % (79) of men and 66.1 % (76) of women) had normal body weight. 6.3 % of observed population had insufficient body weight (of them, men - 12.5 % (2), and women - 87.5 % (14)); 27.9 % had excessive body weight (of them, men - 33.8 % (24), and women - 66.2 % (47)); 13.8 % had obesity I degree (of them, men -11.4 % (4), and women - 88.6 % (31)); 4.3 % had obesity II degree (of them, men – 9.1 % (1), women – 90.9 % (10)); 2.4 % had obesity III degree (of them, men – 0 % (0), women – 100 % (6)).

The examined persons were divided into the following groups by BMI: Group 1 with BMI ≤ 27.0, Group 2 with BMI>27.0 to 36.0, and Group 3 with BMI>36.0. Groups with different BMI levels showed no statistically significant difference in levels of Myocardium. We found no correlation between BMI and Myocardium levels in men. In contrast, in women, a statistically significant difference was found in the levels of Myocardium in BMI Group 1 (15.5 %, $p \leq .02$) and BMI Group 3 (18.9 %, $p \leq .02$) (Fig. 5).

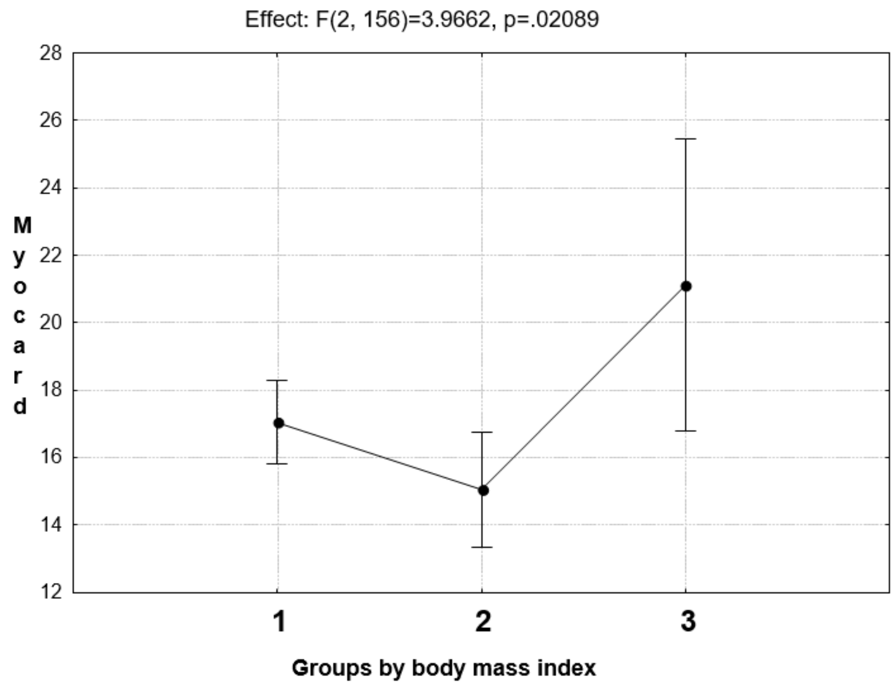

Figure 5. Mean values and confidence intervals of 95% of the index of Myocardium in the three groups by BMI

Thus, the relationship between overweight and the change of index of Myocardium we revealed to a greater extent in women as the women had more cases of overweight.

See Table 3 for the level of statistical significance in the pair-wise comparison of values of Myocardium in different groups by age and BMI.

Table 3. Index of Myocardium in groups by age and BMI

Groups by BMI/Age groups	**< 40**	**40-49**	**>49**
≤ 27,0	-	0.03	0.21
27,0 to 36,0	0.03	-	0.02
> 36,0	0.21	0.02	-
Mean value	17.89	14.98	21.12

We observed a statistically significant difference in the levels of Myocardium in Group 2 and Group 3 by BMI.

Conclusion

The results of performed studies should be considered from scientific and practical points of view. The scientific aspect of this survey is closely linked with its practical aspect, as the new scientific data provides new views on the problem and suggests new solutions. The new scientific findings of this study can be summarized as follows:

1. We observed the highest number of Myocardium index changes up to borderline states in the group of practically healthy persons aged 40 to 49 years. It might indicate the necessity for dynamic health monitoring and timely preventive measures.

2. The Myocardium index increases with age, indicating the depreciation of compensatory mechanisms of ventricular Myocardium and the early stages of violations of electrophysiological properties of the Myocardium. Such violations do not appear on the electrocardiogram but pose the risk of heart disease.

3. Being overweight correlates with a change in the Myocardium index.

4. Autonomic dysfunction in heart rate regulation and the corresponding increase of Myocardium index are more common in older people. This dysfunction is one of the predictors of life-threatening arrhythmias and the indicator of myocardial electrical instability. Therefore, the assessment of the tone of the autonomic nervous system is of considerable importance as an additional component of cardiological screening.

The practical aspect of the study was the obtained evidence of the successful use of the new method – ECG dispersion charting with the device “CardioVisor-12C” – for mass screening of population based on MMUs, along with other screening techniques. The proposed techniques are methodologically simple, highly informative and provide high throughput for mass screening.

The State Healthcare Development Program, "Salamatty Kazakhstan" for 2011-2015, envisages the priority of building of effective healthcare system. The ways to achieve the task include improving and developing preventive medicine based on developing an effective system for detecting and assessing causality factors of diseases, strengthening prevention initiatives and screening studies. Our study is consistent with the activities for implementing the State Healthcare Development Program "Salamatty Kazakhstan", in particular, its sub-item 5.2 "Strengthening of prevention activities, screening studies, improvement of diagnostics, treatment and rehabilitation of main socially significant diseases and injuries."9

The authors have no conflict of interest statement to declare.

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