ISSN 1607-419X
ISSN 2411-8524 (Online)
УДК 614.2:61(091)

Physical activity — history and development of methodology and guidelines

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Received 9 December 2015; accepted 30 December 2015.

Abstract

First studies in the field of physical activity and its role in chronic non-communicable diseases prevention were published more than 50 years ago. Initially, the goal of these investigations was to assess the risk of cardiovascular events during exercises. However, later the assessment of optimal intensity and duration of physical activity within preventive measures became the leading issue of research. Evolution of methodological approaches in physical activity assessment — from subjective methods based on the diaries and questionnaires to modern mobile devices — pedometers and accelerometers, required the changes in physical activity guidelines. Global recommendations on physical activity for health, published by WHO in 2010, leave many open questions due to the lack of an ideal method for physical activity evaluation.

Key words: physical activity, recommendations, evaluation methods

For citation: Orlov AV, Rotar OP, Boyarinova MA, Demchenko EA, Konradi AO. Physical activity — history and development of methodology and guidelines. Arterial'naya Gipertenziya = Arterial Hypertension. 2016;22(2):153–159. ***doi: 10.18705/1607-419X-2016-22-2-153-159.***

Физическая активность — полувековая история формирования рекомендаций и поиска методов оценки

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Статья поступила в редакцию 09.12.15 и принята к печати 30.12.15.

Резюме

Уже более 50 лет проводятся исследования в области физической активности и ее профилактической значимости в развитии хронических неинфекционных заболеваний. Изначально задачей данных исследований была оценка риска сердечно-сосудистых событий на высоте нагрузки, а в дальнейшем ведущей целью стало исследование феномена адаптации к физическим упражнениям как превентивной меры и определение оптимальных характеристик нагрузки. С течением времени менялись методические подходы к оценке интенсивности и длительности физических упражнений — от субъективных методов на основе дневников и опросников до современных мобильных устройств — шагомеров и акселерометров, что находило свое отражение в изменении рекомендаций по физической активности. На сегодняшний день всемирно признанными считаются рекомендации Всемирной организации здравоохранения 2010 года, однако в данной области остаются нерешенными еще многие вопросы ввиду отсутствия идеального для эпидемиологических исследований метода оценки физической нагрузки.

Ключевые слова: физическая активность, рекомендации, методы оценки

Для цитирования: Орлов А. В., Ротарь О. П., Бояринова М. А., Демченко Е. А., Конради А. О. Физическая активность — полувековая история формирования рекомендаций и поиска методов оценки. Артериальная гипертензия. 2016;22(2):153–159. ***doi: 10.18705/1607-419X-2016-22-2-153-159.***

Introduction

Studies in the field of physical activity and its role in the development of cardiovascular diseases (CVD) started in late 1960-ies. Then the first data about the prevalence of hypodynamia in the world and its possible influence on CVD were published. At the same time, several sports organizations attempted to develop and put into practice the recommendations on physical activity, however, the evidence was rather low. Subsequently, observational studies demonstrated protective impact of physical activity on health [1]. At that time, many researchers and medical professionals believed that physical exercises, especially intensive ones (including various sport competitions), were contraindicated to persons aged 45+, since they increased the risk of sudden cardiac death. Thus, recommendations on physical activity are required. In 1972, the American Heart Association (AHA) published

one of the first guidelines in this area for medical professionals, Exercise Testing and Training of Apparently Healthy Individuals: A Handbook for Physicians [2]. They were designed to determine cardiovascular reserve, algorithms for training and decrease of the cardiovascular risk during physical exercises.

At that time, in early 1970-ies, physiological mechanisms of adaptation to physical loads were studied in humans in sufficient detail. A trained body, unlike an untrained one, was shown to have minimum functioning at rest, adequate responses both to standard load and to maximum (stress) load. Physical fitness is possible by regular physical exercises with minimum duration of 8–10 minutes leading to launching of mechanisms not only of emergency adaptation, like upon short and irregular loads, but also of long-term adaptation [3]. Protective effect of physical activity is associated with physical fitness. It is reflected in the first guidelines providing the data of epidemiological studies, published by Pollock et al. in 1973 and called "The Quantification of Exercise Training Programs". The guidelines were mainly addressed to health care managers and covered issues of intensity, duration and types of exercises [4]. They contained recommendations on exercises for 15–60 minutes, 3–5 days a week with intensity leading to the achievement of 60–90 % of heart rate reserve or 50–85 % of maximum oxygen consumption. At that time, key characteristics of physical activity were formulated as well: the type of physical activity (e. g., aerobic, static load), duration, frequency (e. g., number of series of exercises per week), intensity — average (exercise intensity 3.0–5.9 times higher than the intensity at rest) and high (6.0 + times higher than the intensity at rest) [1].

Over the next ten years a considerable amount of published works demonstrated that physical activity of moderate intensity had the greatest protective effect against CVD: 3 to 6 metabolic equivalents (MET) in short recurrent series, for example, regular walking at a moderate pace, with a duration of at least 30 minutes per day [5, 6]. Regarding sufficient data on the role of hypodynamia for CVD, in 1992, the American Heart Association identified it as the fourth leading risk factor after tobacco smoking, arterial hypertension and hypercholesterolemia [7]. Over the next two decades, a lot of attention was paid to issues of hypodynamia. The protective role of physical activity in the CVD development, was shown to be associated with the decrease in low-density lipoprotein cholesterol and blood pressure. In this regard, national guidelines were published in most developed countries [8, 9] with the similar recommendations: daily exercises of moderate intensity for 30–45 minutes a day are indicated to persons of all ages in the absence of medical contraindications [10]; such physical activity reduces the cardiovascular risk, risk of type 2 diabetes mellitus and colorectal cancer [11]; upon achieving such load levels, their gradually increase is possible, which, in turn, will be associated with positive health effects. In 2010, the World Health Organization (WHO) published recommendations on physical activity for prevention of noncommunicable diseases [12], based on large meta-analyses. The analysis included only 10 studies by Russian authors, the rest of the works did not meet international requirements. Russian recommendations in general do not differ from those of the WHO [13]. Basic principles of these recommendations are the following:

1. Persons aged 18 years and over shall do at least 150-minute aerobic exercises of medium intensity a week or at least 75-minute exercises of high intensity a week.

2. The minimum duration of each series shall be 10 minutes of continuous aerobic activity.

3. To achieve an additional positive effect, the duration of aerobic activity may be increased to 300 minutes per week or more.

4. Physical exercises should be performed two or more times a week.

5. For persons unable to do exercises of recommended intensity and duration due to health condition physical activity corresponding to their capabilities is recommended.

6. For persons with motor disability 3 or more days per week of balance exercises are recommended to preserve equilibrium.

However, the type of physical exercises should be specified (efficacy and safety of static loads alone and in combination with dynamic loads); effect of combination of physical activity with a diet to lower blood pressure and low-density lipoproteins; impact of social and economic and

ethnic factors on health [14]. A number of recent publications were critical about the minimum duration of physical exercises: according to some authors, persons with hypodynamia are unlikely to achieve 150-minute activity, and its reduction for untrained individuals is discussed [15]. Many authors agree that any physical activity, even short-term [16], or just staying in the standing position [17] are better than inactivity, however, there is evidence of increasing cardiovascular risk upon irregular physical activity [18]. This paradox can be explained by the lack of the development of long-term adaptation to physical activity in sedentary individuals who occasionally make an effort to increase the level of physical activity [3]. Interestingly, the main evidence for the impact of physical activity on health, including CVD, relies upon subjective methods of assessment.

Indeed, during half century the methodological approaches to the assessment of physical activity have been changed. In 1960–1970-ies, various diaries were used for the assessment of physical activity. Their processing took a lot of time, which resulted in the development of standardized questionnaires. This was difficult as survey participants frequently could not estimate the duration and intensity of their physical load when answering a limited number of questions [19, 20]. In this regard, the WHO initiated the development of the International Physical Activity Questionnaire published in 1998 in full and short versions adapted for in-person and telephone interviews [21]. The short version consisted of nine questions and allowed to evaluate the duration of staying in the sitting position and duration of walking, as well as the involvement in physical exercises of moderate or high intensity during work hours and in spare time. Full version (31 questions) provided more detailed information about physical activity at work, during travel to and from work, working around the house or in the garden, physical exercises in spare time; it also had separate questions about the walking speed and intensity of cycling. The short version of the questionnaire, when adapted, was actively used all over the world and was highly popular in large-scale epidemiological studies due to ease of its use. Thus, in the United States, in 2001–2005, BRFSS (Behavioral Risk Factor Surveillance System) study included a random sample of more than 400 thousand people over the age of 18 years. To collect information, a telephone survey was performed using a short version of the WHO questionnaire [22]. At least 30 minutes of physical activity per day, 5 days a week, were considered sufficient for moderate load and 20 minutes per day, 3 days a week, were considered sufficient for intensive load. According to the study, optimum level of physical activity was reported by 46.7% of females and 49.7% males.

The short version of the questionnaire was also used in the major European study CINDI (Countrywide Integrated Noncommunicable Diseases Intervention) under the auspices of the WHO. This questionnaire was validated in Russia in late 1990-s; the study involved employees of one of Moscow factories, 400 males and 400 females aged 20–59 years, who filled in the questionnaire CINDI. After that their physical conditioning was assessed according to the modified Cooper's test, i. e. assessment of the number of squats per two minutes [23]. The study showed that three issues were the most informative: intensity of physical exercises during work, duration of moderate and intensive physical activity in spare time and at work. The coefficient of correlation between the level of physical activity according to the subjective (based on the questionnaire) and objective (Cooper's test) methodology amounted to 0.14–0.20 for females and 0.25–0.36 for males, which allowed to use this questionnaire in epidemiological studies [24].

Later works showed that the subjective data on the higher adherence to the recommendations on physical activity might be associated with greater awareness of the proper level of physical activity and the choice of the "correct" answer during the survey. Moreover, the majority of persons with hypodynamia cannot adequately assess their level of physical activity [25] and overestimate it, whereas physically active individuals underestimate their load level [26].

In order to solve the problems arising during subjective assessment of physical activity, along with the improvement of the questionnaires, objective methods were developed. In mid-1990-s, the number of publications on the use of pedometers significantly increased. The devices had been used even in 1960-ies, but were included in epidemiological studies only thirty years later. These devices were easy to use,

cheap and increased the interest of participants to physical activity [27, 28]. However, upon assessment of the accuracy of physical activity measured by pedometers, their sensitivity has been subject to criticism — a number of studies showed that pedometers underestimate walking at a slow pace (less than 8 m/min), the accuracy of their measurements decreases with increase of age and body mass index [29, 30]. In addition, their design features do not allow us to estimate the exercise intensity when walking on uneven surfaces, not to mention such types of physical activity like cycling [31]. It should also be noted that the recommended rate of 10,000 steps per day (about 8 km) is not included in the official WHO guidelines. This figure was widely used as the lower limit of adequate physical activity after the first commercially available electronic pedometer called "manpo-kei", which in Japanese means "10,000 steps", was introduced into practice [32].

In the beginning of 2000-s, to assess physical activity, single-axis accelerometers were applied in large-scale epidemiological studies for the first time [33–34]. For example, large US study NHANES [35] included 6800 participants, both adults and children. The recommended physical activity was found in 42% of children and only in 8% of the adult population. The obtained data significantly differed from the results of telephone surveys. The differences could be explained by two main reasons: overestimation of the physical activity in case of questionnaires and its underestimation in case of single-axis accelerometers. Indeed, later a number of studies showed that single-axis accelerometers reflecting only one-directional movement were not accurate enough to reflect the intensity and duration of the load [36]. In this regard, three-axial devices began to be actively used, allowing to estimate movement not only forward but also up and down and to the side [37]. When comparing energy costs and the amount of oxygen consumed, three-axial accelerometers make it easier to get objective data on the energy cost of various physical loads [38]. In comparison with one-axial accelerometers, indicators of three-axial devices are more accurate in assessing the duration and intensity of physical activity, including uphill or climbing stairs, cycling, swimming and so on. They also allow to assess time spent sitting or lying down more accurately, assess movement during sleep, which in turn allows indirect evaluation of sleep quality [39].

Due to the fact that the evidence for the relationship of physical activity and CVD relies upon the data from questionnaires, a number of studies of objective methods of physical activity assessment discuss possible modifications of ideas about this relationship and also about possible revision of the recommendations on the intensity and duration of physical activity. In the majority developed countries appropriate epidemiological studies are performed, while in Russia the majority of publications on the relationship between physical activity and CVD is still based on the use of questionnaires. No data on objective assessment of physical activity have been published by the time of preparation of this review.

Thus, in conclusion, the issues of physical activity over the past half century were given much attention. Subjective methods although relative easy-to-use and convenient in epidemiological studies show low efficacy in the physical activity assessment, therefore, instrumental approaches are methods of choice. Their widespread use can lead to significant adjustments in the recommendations on physical activity for prevention of chronic noncommunicable diseases that remain the leading cause of mortality in the world.

Conflict of interest

The authors declare no conflict of interest.

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