Genes, Exercise and Health

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Exercise and physical activity as part of one's lifestyle throughout the life span improve physical fitness. Exercise, a discipline involving the study of how it alters the structure and function of the human body, is performed to improve, maintain or express a particular type of physical fitness whereas physical activity as the one performed by the body for purposes other than the specific development of physical fitness.[1] The science of exercise with a long history, has expanded beyond traditional physical education and currently in addition to its being a vital part of sports participation for better Performance and recreational persuits has immense life long advantages in human health, and well-being of our minds and bodies. Its specific role in preventive, rehabilitative and diagnostic applications for health and quality of life particularly in today's stressful society, promoted by American College of Sports and Medicine (ACSM), is confirmed. It as a complex and advanced field of science to identify and understand important clinical sport athletics environmental and academic issue, is now well recognized[2]. It has resulted now into an increasingly growing industry for selling exercise-knowledge and equipment to the community.

Although the acute and chronic adaptations of human body systems e.g neuromuscular, cardiopulmonary, endocrine, metabolic and immune in particular, to variety of exercise training programs and areas of sports medicine, as well as in relation to nutrition, diet and weight control have been described for years[1] and the underlying cellular and molecular mechanism are still being explored with variety of exercise and training programs. Achievements in both and applied research became possible due to the applications of new or improved research techniques or application of techniques to new conditions: the application of percutaneous needle biopsy technique and the use of stable isotopes facilitated human muscle sampling and study of cellular metabolism during rest, exercise and post exercise conditions, contemporary technologies including MRI, MR spectroscopy and variety of genetic technologies to study molecular function and adaptability of various human systems to different exercise intensities, though at a slow pace.[1,8] This eventually lead to development of specific area of exercise physiology like kineisogenomics- genetics in exercise or physical activity prescription and genomic physiology.

Chronic diseases, the world society is facing, present a colossal burden in terms of both medical costs and human suffering. Mostly these are linked to increased physical inactivity; infact are rooted in it. Exercise biology and intervention considered potentially effective approaches to combat these, are least practiced; possibly due to undervalued for health and lack of understanding the cellular, molecular, and genetic bases of diseases. Medical practitioners need to believe that exercise is more than a tool (e.g., treadmill testing of humans for cardiac dysfunctions) and is now an established area of clinical exercise Physiology. Commonly chronic diseases for which exercise has as a proven preventive role, has been dealt by many including Harvard Fatigue Laboratory.[1] In recent years enormous data has been provided for: Neurobiology, muscle metabolism,[16] CHD, hyperlipidemia, hypertension, stroke, and peripheral vascular diseases,[20] DMT2 and obesity,[21] CPOD and asthma,[25] immunity and cancer of colon, breast and prostate, osteoporosis, lower back pain.[1-2] Routine regular exercise training, including a high-intensity interval walking programme, improves cardiorespiratory fitness and alleviates lifestyle-related diseases, such as obesity, hypertension and dyslipidaemia. However, the extent of improvement has been shown to differ substantially among individuals for various exercise regimens.[28] The application of an individual's genetic information to health care–personalized medicine, in relation to exercise interventions on human physical performance and elite athletes has been discussed.[28]

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The application of molecular and genetic technologies phenotypes and disease has formulated human gene map for training, physical performance and health-related phenotypes. Thus, association studies, with candidate genes, genome-wide scans with polymorphic markers, and single gene defects causing exercise intolerance to variable degrees, have appeared in recent years. It has been recognized now that genes and markers with evidence of association or linkage with a performance or fitness phenotype in sedentary or active people, in addition to acute exercise, or for training-induced changes are positioned on the genetic map of all autosomes and the X-chromosome.[8] Fitness and performance genome map is being updated every year. It now includes 214 autosomal gene entries and quantitative trait loci plus seven others on the X chromosome, eighteen mitochondrial genes shown to influence fitness and performance phenotypes.[31] Ofcourse, many more gene-exercise interaction effects yet to be considered since mostly studies are based on small sample size and evidence may be insufficient to support that DNA sequence variants in a given gene are reliably associated with human variation in fitness and performance traits.[31] A few genes associated with the either level of physical activity or indicators of sedentarism have been incorporated into it. Thus, the map is growing in complexity and progress is being made.

Individual physiological responses to exercise training particularly with respect to risk factors of disease differ. Further, inter-individual variability in the improvement of risk factors for lifestyle-related diseases following exercise training are also identified. All these may be attributed to gene polymorphisms although the fractions of the variability explained by the polymorphisms are small (5%), suggesting more research on better study designs and approaches of statistical evaluation so that an enhanced understanding of this phenomenon may guide for more effective exercise prescription for lifestyle-relalted diseases.[28] However, identification of gene variants explaining differences in physical capabilities and training-induced effects between subjects is underway. A review on DNA polymorphisms and their association with elite athlete status and training responses reported at least 36 genetic markers (located within 20 autosomal genes, mitochondrial DNA and Y-chromosome) linked to elite athlete status and 39 gene markers (located within 19 genes and mitochondrial DNA) may explain, in part, an inter-individual variability of physical performance characteristic in response to endurance/strength training. Preliminary data points towards using some of these genetic markers in an individually tailored prescription of lifestyle/exercise for health and sports performance. The physiological and molecular genetic mechanisms by which gene polymorphisms interact with exercise remains to be clarified. Speculation about the lack of daily physical activity inducing evolutionary selected mechanisms to use or loose (one related to nutritional status) has also been made.

Progress is slow in the filed of genetics of fitness and performance in general and of exercise and sports medicine in particular, primarily due to non-utilization of advances of genetic and genomic technologies by scientists to understand the role of genes and sequence variations in exercise-related traits. Recent reports on sample size, quality of phenotype measurements, quality of the exercise program of physical activity exposure, study design, adjustment for multiple testing, quality of genotyping, and other related study characteristics in relation to exercise, fitness and performance genomics suggested that high quality research design with replication studies of large sample size are urgently required. Although, main threats and ethical controversies associated with the application of molecular biology in sport are considered an important obstacle to wider application of genetics in training, yet careful use related to fitness and health-related disease still can not be ruled out. Likewise, as exercise training regulates the expression of genes encoding various enzymes in muscle and other tissues, more efficient genomic-based research approaches in sports will help clarify several aspects of human biology and physiology e.g., RNA and protein level regulation under specific circumstances and explore the "sports genes".[36]

There is dire need to start and strengthen regular programs about physical activity as a preventative measure at home, in academic institution of all types, offices, medical circles and in the popular media to adopt it one of the lifestyles for improved health and fitness of the nation, as recommended by American College of Sports Medicine.[1] Collaborative and multidiscipline research activities in exercise physiology, fitness and lifestyle-related diseases using contemporary techniques of molecular biology and genetic engineering should be properly designed and conducted.

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