International Journal of Science and Healthcare Research
Vol.7; Issue: 3; July-Sept. 2022
Website: ijshr.com
Review Article *ISSN: 2455-7587*

Accurate Interpretation of Stability of Human Health and Ageing Trajectory through a Single Objective Measure of Homeostasis

R. Vinodh Rajkumar

Medical Anthropologist, Physiotherapist & Gerontologist. Director - Prabhanjeet Vitalityarium. Rajapalayam – 626117 Tamilnadu.

DOI: https://doi.org/10.52403/ijshr.20220719

ABSTRACT

Health stability is directly proportional to homeostatic stability. Overall efficiency of our body, both at rest and during physical activity, is the product of homeostasis. Human body is a magnificent interconnection and collaboration of various specialized cells and organs, capable of naturally obstructing and overcoming diseases with optimal survival competence. Homeostasis at rest and during exercise are mutually dependent/benefitting physiology that ensure and enhance the stability of human health and healthy ageing trajectory. Homeostasis enables us to withstand even major dysfunctions or disabilities by virtue of its individual-specific adaptability to unexpected challenges to survive. On the other hand, homeostasis has been almost a completely forgotten fundamental of physiology in all the aspects of health care. Numerous diagnostic tests have been available to assess multiple physiologic parameters but quite often the results of each test are not unified to interpret the homeostatic condition of the individuals. Probably, this non-homeostatic approach to deal with human health and diseases led to pathogenic orientation instead of salutogenic orientation to move in a health-promoting direction as viewed by Aaron Antonovsky. Homeostasis cannot be understood solely by examining the functions of human body in resting conditions, thus, testing of homeostatic efficiency through structured and customized physical activity becomes crucial. Man has discovered precision units to measure overall efficiency of various machines, but astonishingly not yet a single objective measure for the overall efficiency of his body. Individual-specific longitudinal evaluation of the overall homeostatic efficiency of healthy and unhealthy individuals on the basis of exercise performance still remains as an under-developed domain in medical profession. This article attempts to (i) validate the importance of accurately interpreting the stability and instability of human health and ageing trajectory using 'exercise performance', and (ii) establish 'Tolerating Increasable Measurable Exercises - (TIME)' as the most credible and indispensable objective measure of homeostasis.

Keywords: Homeostasis, Exercise Physiology, Exercise Tolerance, Exercise Performance

INTRODUCTION

Health stability is directly proportional to homeostatic stability. Overall efficiency of the body, both at rest and during physical activity, is the product of homeostasis. Human body is a magnificent interconnection and collaboration of various specialized cells and organs, capable of naturally obstructing and overcoming diseases with optimal survival competence. Homeostasis at rest and during exercise are mutually dependent/benefitting physiology that ensure and enhance the stability of human health and healthy ageing trajectory. Homeostasis enables us to withstand even major dysfunctions or disabilities by virtue of its individual-specific adaptability to unexpected challenges to survive. On the other hand, homeostasis has been almost a completely forgotten fundamental of physiology in all the aspects of health care. "Essentially all organs and tissues of the

body perform functions that help maintain nearly constant conditions in the internal environment. Physiologists call this high level of internal bodily control *homeostasis*. Each cell benefits from homeostasis, and in turn, each cell contributes its share toward the maintenance of homeostasis. This reciprocal interplay provides continuous automaticity of the body until one or more functional systems lose their ability to contribute their share of function. When this happens, all the cells of the body suffer. In disease states, functional balances are often seriously disturbed and homeostasis is impaired. Extreme dysfunction leads to death; moderate dysfunction leads to sickness. Thus, when even as single disturbance reaches a limit, the whole body can no longer live".[1] "Underlying individuals' unique, invaluable, and enigmatic metaphysical qualities, the human organism is, in a physical sense, essentially a self-regulating biochemical machine. At any moment, our thoughts and feelings, our actions, metabolism and physical well-being all stem from the sum of dynamic, intricate biochemistry working within a distinctive genetic context. We are truly wonderfully crafted".[2] "Homeostasis is an underappreciated, far too often ignored central organizing principle of physiology. Disruption of homeostatic mechanisms is what leads to disease, and effective therapy must be directed toward re-establishing these homeostatic conditions".[3] Numerous diagnostic tests have been available to assess multiple physiologic parameters but quite often the results of each test are not unified to interpret the homeostatic condition of the individuals. Probably, this non-homeostatic approach to deal with human health and diseases led to pathogenic orientation instead of salutogenic orientation to move in a health-promoting direction as viewed by Aaron Antonovsky. Man has discovered precision units to measure overall efficiency of various machines, but astonishingly not yet a single objective measure for the overall efficiency of his body. "Well-being of individuals involves two main conceptual parts, one dealing with longevity, and the other dealing with morbidity. Any single summary measure of health and well-being of individuals and of populations will need to account for both these aspects. Each individual is born and lives out a lifetime that consists of moving through different health states that terminates at a different time of death. The universe of health states that humans experience is immense".[4] Both health and diseases are the consequence of highly complex multifactorial background. "Individual health ultimately reflects not just the singular influence of biology, but also the complex constellation of many other dimensions like social determinants, so that we can measure what is ultimate, not merely what is important".[5] "There is no single variable that can be used to describe health, and health cannot be measured directly. Health measurement requires several steps and involves the evaluation of several health-related indicators".[6] It is always absolutely futile in the domains of 'health care' and 'disease prevention' if the health-related indicators or physiologic parameters are not combined together to decipher individual-specific homeostasis and ageing trajectory. "Compression of morbidity," of James Fries holds that if the age at the onset of the first chronic infirmity can be postponed more rapidly than the age of death, then the lifetime illness burden may be compressed into a shorter period of time nearer to the age of death.[7] "Three patterns of healthy ageing trajectories were identified: 'high stable', 'low stable' and 'rapid decline'. People with multimorbidity displayed worse healthy ageing trajectories than those without multimorbidity or relatively healthy. With multimorbidity it was still possible to achieve health ageing. Instead of regarding older people as frail and potential burdens of public health, policy makers and practitioners should actively promote healthy ageing in the recognition that ageing is not synonymous with ill health".[8] "Ageing is characterized by great variability in the health status.

Establishing non-pharmacological interventions that promote the adoption of a healthy lifestyle from early on could benefit older people to increase the number of years spent in a good health".[9] Physically inactive older adults were more likely to exhibit worse trajectories of health with age than those that engaged in some form of physical activity. Physical activity promotion should be a key focus of healthy ageing policies to prevent disability and fast deterioration in health.[10] "The human body is dynamic and does not follow the linear laws. Doctors have been predicting the unpredictable futures of patients based on very few knowable parameters of the body during the routine check-up. Unfortunately, time evolution in any dynamic system follows a non-linear rule. To know the future of any individual one should be able to understand the whole organism (man). This is impossible in the present set up in science. Routine screening of apparently healthy people is the most dangerous activity in hi-tech medical care system. Trying to keep the well healthy by promoting good life style and acquiring tranquillity of mind should be the thrust areas. Over investigation and over treating damages the inbuilt repair mechanism of the human system and might even result in death".[11] "Ivan Dominic Illich argues that industrialised society widely impairs quality of life by overmedicalising life, pathologizing normal conditions, creating false dependency, and limiting other more healthful solutions. This frequently caused more harm than good and rendered many people in effect lifelong patients".[12] Many unresolved complications in the medical profession could be eradicated, and the health care approaches streamlined just by ensuring profound applied knowledge in homeostasis. Understanding homeostasis of human beings based on their physical fitness traits still remains as an under-developed domain in medical profession, and this should be regarded as a perilous foundational flaw.

Tolerating Increasable Measurable Exercises (TIME)

All health-related variables are linked to homeostasis, and they also constantly undergo dynamic changes within narrow limits, at rest and during physical activity, to sustain life. Laboratory investigations of health-related indicators also pose multiple challenges. "Master Health Checkup (MHC) is a battery of tests done to detect and identify Non-Communicable Diseases (NCDs) early and may help in adopting timely interventions in this era of increasing life style diseases. Biochemical investigations of MHC include - Haemoglobin, Total WBC count, Total RBC count, Platelets, ESR, Peripheral Smear, Urine routine (including urine glucose and ketone bodies), Serum electrolytes, Fasting Blood Sugar, Postprandial Blood Sugar, HbA1C, Cholesterol, Triglycerides, HDL, VLDL, Bilirubin (total, indirect and direct), Alkaline Phosphatase (ALP), Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Gamma-glutamyl transferase (GGT), Albumin, Globulin, Serum Urea, Creatinine, Uric Acid, Thyroid function tests, Prostate Specific Antigen or PAP smear, X-ray, ECG and Abdominal ultrasound".[13] "For proper interpretation of study results, further reliability assessment is required to determine the variability from repeated samples from the same individual, and variation among individuals. Reliability has two components: repeatability, when repeated testing of the same specimen under the same conditions yields the same result; and reproducibility, when repeated testing of the same specimen in different laboratories yields the same result. A highly reliable test will give very similar results on repeated tests; in a statistical sense the variance is small".[14] "Laboratory analyses are crucial for diagnosis, follow-up and treatment decisions. But each step in the laboratory testing is vulnerable to errors, which can then potentially generate erroneous results and finally jeopardize patient safety".[15] "Patient safety

emphasizes the reporting, analysis, and prevention of medical errors that often lead to adverse events. While many areas of health care are still struggling with the issue of patient safety, laboratory diagnostics has always been a forerunner in pursuing this issue".[16] Table 1 shows few important variables that are fundamental determinants of health, and each of these variables are usually measured in specific units.

Table 1: Examples of units of measure of variables of health. Is there a way to put together all such measurements to standardize the interpretation of individual-specific homeostasis?

Determinant of Health	Unit of Measurement
Hemoglobin	gm/dL
Red blood cells	million cells /mm^3
White Blood cells	thousand cells/mm^3
Blood pressure	mmHg
Respiration	Breathing rate: breaths/min Lung volumes and capacities: mL
Heart rate	beats/minute
Temperature	Fahrenheit or Celsius
Blood glucose	mg/dL
Fat mass	kilogram
Fat free mass	kilogram
Nerve conduction velocity	meters/second
Acid-base balance	0 - 14
Lipid profile	mg/dL
Platelets	lakh cells/µL
Plasma Proteins	g/L
Glomerular Filtration Rate	mL/min
Hormones	ng/dL or pg/dL
Electrolytes	mmol/L
Liver enzymes	U/L
BMI	kg/m^2
Somatotype	Endomorphy : Mesomorphy : Ectomorphy
Energy intake/output	Calories

All such variables of health contribute together to a single phenomenon 'Homeostasis'. Should not be there a single objective measure of individual-specific homeostasis by integrating these multi-variables? Can 'Physical Fitness' provide a single objective measure of individual-specific homeostasis? "Physical Fitness is an integrated measurement of all the functions (musculoskeletal, cardio-respiratory, circulatory, metabolic and neurological) and structures involved in performing Physical Activity. Improving Physical Fitness should be considered as a primary objective in promoting public health".[17] Measures of physical fitness are indicators of positive health and such measures are identified under their discrete headings of agility, flexibility, power, speed and reaction time, strength, cardiovascular capacity, body composition and posture.[18] "Exercise represents a major challenge to whole-body homeostasis provoking widespread perturbations in numerous cells, tissues, and organs that are caused by or are a response to the increased metabolic activity of the contracting skeletal muscles. To meet this challenge, multiple integrated and often redundant responses operate to blunt the homeostatic threats generated by exercise-induced increases in muscle energy and oxygen demand. Molecular techniques led to greater understanding of the multiplicity and complexity of cellular communications done by muscle with other organs (adipose tissue, liver, pancreas, bone, brain) to mediate beneficial effects on health and performance".[19] Exercise performance and almost all the human physical capabilities (running, jumping, walking, stair climbing, throwing, climbing, swimming, rowing, squatting) also possess multi-variables that can be measured through multiple devices. Deriving a single objective measure of individual-specific homeostasis based on exercise performance needs a more specific variable; 'time'. Can the National records and World records in running events be recognized without measuring the performance of athletes in

association with time? From this view point, 'Tolerating Increasable Measurable Exercises – TIME' has been recommended to objectively measure the stability and instability of homeostasis. Needless to say, a stop clock is required to record the 'time consumption data' of exercise performance of the athletes/clients/patients whilst some equipment like treadmill display various performance parameters including time. By applying TIME protocol, the health standards of individuals could be precisely evaluated by assessing their ability to tolerate increasable and measurable exercises performed in structured physical activity formats being monitored flawlessly in association with time (Table 2).

Table 2: There are myriad ways to design simple to complex individual-specific exercise plans for healthy and unhealthy individuals, monitor their progress in association with time, and skillfully challenge them with higher dosages to facilitate better exercise performances. Only few examples of the units of measurement of exercise performances have been shown.

COMPONENT		MEANING
T	Tolerating	Ability to withstand
I	Increasable	repetitions, sets, loads, distance, exercise variations
M	Measurable	Kg, lbs, Km/h, RPM, Time, VO_2 max
E	Exercises	Structured physical activity monitored in association with time

Almost all exercise variables can be measured easily and non-invasively. Exercise tasks using free weights (dumbbell, barbell, medicine ball, etc.,) can be used for creating interesting exercise plans and enhancing the challenges with higher loads based on the magnitude of fitness progressions. For individuals who cannot handle free weights or any exercise machine (due to disease severity, disability or ageing) exercise tasks can be formulated based on simple basic postures and movements representing activities of daily living (ADL). There are many increasable and objectively measurable exercise variables but it is prudent to monitor the 'total time consumed' to complete the exercise prescriptions of every exercise plan. So, in fact, every exercise session of a person (either athlete or non-athlete or patients) becomes a vital procedure to collect key information about their health status. If the assigned exercise tasks are completed through lesser time consumption than before (in minutes or seconds) as a result of dedicated exercise participation, it is obviously a clear sign of progression in homeostatic condition of an individual. Further details of favorable homeostatic adaptations in response to exercise participation can also be assessed (few measurable variables shown in Table 1) based on the necessity, and availability of affordable resources. Postponement of fatigue, quicker recovery from fatigue, ability to do more work (more volume than before) with time kept constant, ability to complete same dosage of work (same volume as before) faster than before, are the principal outcomes that arise out of adaptations to regular and structured exercise participation. Progressions in exercise tolerance should be justified without ruining or diminishing the quality of exercise executions. More specifically, incomplete range of joint motion and incorrect dynamic postures (counter-productive movements) could lead to false positive impressions that the assigned exercise tasks were completed at a faster rate than earlier exercise performances. Improved exercise tolerance may or may not be associated with transformations in the body composition (fat mass and fat free mass) that cannot be easily understood also, due to persistent and abundant inexplicable confounding interactions occurring in every person's life. TIME protocol is an infinite sphere for discussion, thus, for simplicity, only two examples have been shown in Table 3 and Table 4.

Table 3: 12 minutes run performance (Cooper's test) of a 46 years old Indian male with improvements in body composition and exercise performance after six months of training (predominantly strength training). Without stipulating the time, improvements in the run endurance cannot be investigated or interpreted meaningfully.

	INITIAL	AFTER 6 MONTHS
Body weight	83 Kg	81 Kg
Fat %	33	29
Fat mass	27.5 Kg	23.5 Kg
Fat free mass	55.5 Kg	57.5 Kg
Distance reached	2 Km	2.6 Km
Average pace	10 Km/h	13 Km/h
Cadence	172 steps/minute	180 steps/minute
Step length	97 cm	120 cm

Table 4: Progression in maximum number of push ups of a 35 years old Spanish male in association with changes in body weight and Heath-Carter anthropometric somatotype rating (Endomorphy, Mesomorphy and Ectomoprhy). This individual underwent supervised strength training sessions (twice per week). Without observing the time consumption for the total number of push ups, the data could be meaningless.

	INITIAL	AFTER 1 MONTH
Body weight	78 Kg	75.5 Kg
Endomorphy	8.2	7.1
Mesomorphy	5.4	5.4
Ectomorphy	1.7	2
Push ups max	19 repetitions in 30 seconds	30 repetitions in 28 seconds

To understand a person's health stability/instability and ageing trajectory, the only best option is to periodically and precisely compare his/her own exercise tolerance with his/her own baseline exercise performance data of every exercise plan. Ideally various other important variables of exercise performance and health (like body composition, flexibility, somatotype, vital signs, reference values of physiologic parameters, lifestyle, etc.,) should also be assessed and correlated with either negative or positive results in exercise tolerance. Illnesses could also decrease the fitness levels due to their negative impact on the body composition and stability of homeostasis, therefore, documentation of the history of illness becomes highly relevant while adapting TIME protocol. Kinanthropometry allows us to analyze variations in physical dimensions and body composition.[20] Gaston Beunen and Jan Borms defined kinanthropometry as a discipline that investigates the relationship between human structure and function.[21] Experts with their core functions in the field of exercise need to develop a wide range of skills and experience in kinanthropometry, and in customizing/prescribing suitable exercise dosages (preferably in the sub-maximal exercise capacity range), monitoring and documenting the exercise performances to objectively validate the homeostatic stability/instability of their clientele/patients. TIME protocol can be administered as self-selected exercise pace (varying rest intervals between the exercises or sets as voluntarily chosen by the exerciser) or stipulated exercise pace (fixed rest intervals between the exercises or sets as formulated by the Exercise expert). Self-selected exercise pace is safer and more convenient than stipulated exercise pace, especially for the non-athletic and patient population.

DISCUSSION

"Health is more than a 'theoretical abstraction' because there is an "objective reality". Health explains life, and life is an objective reality. Health is a valuable tool that "drives" health policies and influences the determinants of health care".[22] Exercise tolerance or intolerance can objectively reveal individual-specific homeostasis, healthy stability/instability, and healthy or unhealthy ageing trajectory. "Human neuro-musculo-skeletal system integrates together and manages the gravitational forces to develop and maintain normal posture, basic motor skills and highly skilled motor skills in order to survive healthily. Insufficient exposure of neuro-musculo-skeletal system to the gravitational forces could lead to Gravitational Torque Deficiency Syndrome (GTDS). GTDS can be the sole etiological factor for various medical ailments".[23] "Exercise intolerance is an attractive therapeutic target because it is a primary determinant of quality of life, can be quantified objectively, reproduced and modified. Cardiopulmonary exercise testing on a treadmill or a bicycle ergometer provides the most accurate, reliable and reproducible assessments of exercise tolerance, and yields multiple important outcomes, including METS, exercise time, exercise workload, blood pressure and heart rate responses, and rate-pressure product. Submaximal exercise capacity is a more important outcome variable than peak exercise capacity because it is more applicable to everyday life and is relatively effort independent".[24] Resistance training can be effective without the severe discomfort and acute physical effort associated with fatiguing contractions.[25] "The capacity for human exercise performance can be enhanced with

prolonged exercise training, whether it is endurance or strength-based. Endurance and strength training adaptations not only contribute toward sporting excellence but also toward the delayed onset of age-related diseases. Our continued drive to understand how to prescribe exercise to maximize health and/or performance outcomes means that our knowledge of the adaptations that occur as a result of exercise continues to evolve".[26] "It is difficult to determine the characteristics of physical activity related most specifically to different aspects of health, since there are several dimensions of physical activity behaviors but these dimensions (aerobic capacity, flexibility, muscular strength, weight regulation) are certainly interrelated and the relative importance of each of these dimensions to health shifts with age. Physical activity is a complex behavior and is often difficult to describe".[27] Of all the fields that comprise the physiological sciences, exercise is one of the hardest to categorize even though it is a common everyday experience for nearly everyone whether it is a formal exercise program or simply walking from one place to another.[28] "Motivation is the key factor behind the elucidation of exercise behavior, therefore its investigation is imperative. It may be necessary to locate the pre-existing motives of exercise participants in order to enhance the participation and maintenance in exercise".[29] "Whether it be low interest or low perceived competence, the physical activity participation data indicate that many people are either unmotivated (having no intention to be more physically active), or are insufficiently motivated in the face of other interests or demands on their time. Motivation is a critical factor in supporting sustained exercise, which in turn is associated with important health outcomes".[30] Both intrinsic and extrinsic motivations impact habitual physical activity.[31] While non-exercisers tend to develop unfavourable body composition and acquire morbidities, excessively motivated exercisers also would experience unpleasant outcomes. "Overtraining Syndrome (OTS) reflects the unsuccessful attempt of the body to cope with the physiological and psychological stress of exercise training and life-the total allostatic load and resultant wear and tear on the body from chronic stress. Two varieties of OTS have been proposed, a hypoarousal and a hyperarousal form. This categorization is based upon the finding of divergent symptomology in some physiological and psychological parameters of athletes. Hypoarousal is also called parasympathetic or Addison's OTS. It is commonly seen in endurance athletes (long-distance runners, rowers, cross-country skiers, cyclists, and swimmers). Hyperarousal is also called sympathetic or Basedow's OTS. It is commonly seen in power athletes (sprinters, jumpers, and weight lifters) and occurs slightly less frequently than the hypoarousal form. The two forms have some similar characteristics and warning signs, particularly the persistent decline in physical performance. Decreased physical performance, increased incidence of infections, decreased maximal lactate response to exercise, amenorrhea in women, hypogonadism in men, loss of competitive desire, weight loss, disturbed sleep, fatiguability are some common features of hyperarousal OTS and hypoarousal OTS".[32] TIME protocol should be included in the field of geriatrics and gerontology. Preventing loss of physical and cognitive function and improving mental health and social engagement are the benefits of physical activity that improve chances of ageing successfully and healthily.[33] "Like a number of geriatricians, I have come to believe that modern medicine does not work well for old people. Old patients serve as a mirror, reflecting the limitations and sometimes the absurdities of modern medicine. There are three areas that are particularly problematic for old people: the medicalization of everyday life, the primacy of diagnosis, and reimbursement for medical care".[34] "Health care professionals should possess flawless foundational knowledge about homeostasis. From a novel facet of critical medical

anthropology, a 'HEALTH paradigm' that incorporates Homeostasis, Evidence-based practice, Activism for Health, Lifestyle medicine, Transdisciplinarity and High performance team has been recommended, especially to develop a nation-specific school of thought for public health".[35]

CONCLUSION

Homeostasis at rest and during exercise are mutually dependent/benefitting physiology. Health and disease depend on the equilibrium and imbalance, respectively, in this mutually dependent physiology. 'Breathing rate and rhythm' could be regarded as a single objective measure of homeostasis at rest whilst 'Exercise tolerance' regarded as a single objective measure of homeostasis based on physical activity. Thus, in order to understand an individual's health, his/her homeostasis at rest and during exercise should be examined objectively. Narrow range of fluctuations in exercise performance standards as compared to personal baseline exercise performance standards looks acceptable and compatible with natural homeostatic fluctuations within narrow limits. But persistent decline or irreversible decline in exercise performance could be a cautionary signal to monitor all the well-known key variables that regulate health stability and healthy ageing. Improvements in exercise performance is also a cautionary signal to retain the elevated fitness level and epigenetic efficiency with proper rest, nutrition, hydration, sleep, exercise adjustments and spiritual intelligence. Individual-specific exercise prescriptions are always a daunting challenge, especially for the individuals (regardless of their age) who are traveling along the unhealthy ageing trajectory associated with many symptomatic and asymptomatic dysfunctions/morbidities of the body. Individual-specific longitudinal evaluation of the overall homeostatic efficiency of healthy and unhealthy individuals on the basis of exercise performance should be fervently taken into account. From the perspective of fight or flight, sprinting speed measured in kilometer per hour could be the single most reliable unit of measure of homeostasis and overall efficiency of the human body because this intense physical activity has been a great demonstration of individual-specific homeostatic robustness. But speed of work can be assessed in association with time through multiple ways based on the individuals' age, health status, occupation, exercise experience, control over posture and movement, lifestyle and goals. A single objective measure of homeostasis based on exercise tolerance will suffice to understand a person's immunocompetence, resistance to diseases, prospective ageing trajectory, recovery from any illness, etc., TIME protocol usually requires inexpensive non-invasive diagnostic instruments, and it is an excellent method to keep people motivated to improve or maintain their health and eustress by validating the stability and instability of health and ageing trajectory with ultimate precision.

Acknowledgement: None

Conflict of Interest: None

Source of Funding: None

REFERENCES

1. Guyton and Hall Textbook of Medical Physiology. 12th Edition. Philadelphia, Pa.: Saunders/Elsevier, 2011.
2. Genuis SJ, Sears ME, Schwalfenberg G, Hope J, Bernhoft R. Clinical detoxification: elimination of persistent toxicants from the human body. *ScientificWorldJournal*. 2013; 238347.
3. Billman GE. Homeostasis: The Underappreciated and Far Too Often Ignored Central Organizing Principle of Physiology. *Front Physiol*. 2020;11:200.
4. Dennis G. Fryback. Appendix C Methodological Issues in Measuring Health Status and Health-Related Quality of Life for Population Health Measures: A Brief Overview of the "HALY" Family of Measures. National Academies Press (US); 1998.

5. Howard K. Koh. The Ultimate Measures of Health. Public Health Rep. 2011;126 (Suppl 3): 14-15.
6. Andras P. Keszei, Marta Novak, David L. Streiner. Introduction to health measurement scales. Journal of Psychosomatic Research. 2010; 68 (4), 319 – 323.
7. Swartz A. James Fries: healthy aging pioneer. Am J Public Health. 2008;98(7):1163-1166.
8. Nguyen H, Moreno-Agostino D, Chua KC, Vitoratou S, Prina AM. Trajectories of healthy ageing among older adults with multimorbidity: A growth mixture model using harmonised data from eight ATHLOS cohorts. 2021: PLOS ONE 16 (4): e0248844.
9. Daskalopoulou, C., Koukounari, A., Wu, YT. et al. Healthy ageing trajectories and lifestyle behaviour: the Mexican Health and Aging Study. 2019; Sci Rep 9, 11041.
10. Moreno-Agostino, D., Daskalopoulou, C., Wu, YT. et al. The impact of physical activity on healthy ageing trajectories: evidence from eight cohort studies. Int J Behav Nutr Phys Act, 2020; 17, 92.
11. BM Hegde. Weapons of Mass Destruction, http://www.bmhegde.com/wepon_masdistro .htm , accessed on 15.07.22.
12. "Iatrogenesis", A Dictionary of Sociology, Encyclopedia.com. updated 31 May 2020.
13. Sathiyamoorthi S, Anand DP, Muthunarayanan L. Is Master Health Checkup the Answer to Tackle the Rising Non-Communicable Disease Burden in India? - A Cross-Sectional Study. *J Lifestyle Med*. 2019;9(2):111-118.
14. Betsy Foxman. Determining the Reliability and Validity and Interpretation of a Measure in the Study Populations. Molecular Tools and Infectious Disease Epidemiology. Aademic Press, 2012; 117 – 132.
15. Cornelia Mrazek. Giuseppe Lippi, Martin H Keppel, Thomas K Felder, Hannes Oberkofler, Elisabeth Haschke-Becher, Janne Cadamuro. Errors within the total laboratory testing process, from test selection to medical decision-making – A review of causes, consequences, surveillance and solutions. Biochem Med (Zagreb). 2020; 30 (2): 020502.
16. Julie A. Hammerling. A Review of Medical Errors in Laboratory Diagnostics and Where We Are Today, Laboratory Medicine, 2012; 43 (2), 41-44.
17. Fonseca del Pozo FJ, Alonso JV, Alvarez MV. Orr S, Llorente Cantarero FJ. Physical fitness as an indicator of health status and its relationship to academic performance during the prepubertal period. Health Promot Perspect. 2017;7(4): 197-204.
18. Lamb, K.L., Brodie, D.A, Roberts, K. Physical fitness and health-related fitness as indicators of a positive health state. Health Promotion. 1988. 3(2), 171-182.
19. John A. Hawley, Mark Hargreaves, Michael J. Joyner, Juleen R. Zierath. Integrative Biology of Exercise, Cell, 2014; 159 (4), 738 – 749.
20. Navas Harrison DJ, Perez Pico AM, Mayordomo R. Impact of Kinanthropometric Differences According to Non-Professional Sports Activity Practiced. Applied Sciences. 2021; 11(11): 5063.
21. Arthur Stewart. Kinanthropometry Section Editor. Kinanthropometry – the interdisciplinary discipline. Journal of Sports Sciences. 2007; 25:4, 373.
22. Bourne, Paul. Health measurement. Health. 2010. 2. 465 – 476.
23. https://www.researchgate.net/publication/292137264_GRAVITATIONAL_TORQUE_DEFICIENCY_SYNDROME_GTDS, accessed on 16.07.2022
24. Dalane W. Kitzman, Leanne Groban. Exercise Intolerance. Heart Fail Clin. 2008; 4 (1): 99 – 115.
25. Folland JP, Irish CS, Roberts JC, et al. Fatigue is not a necessary stimulus for strength gains during resistance training. British Journal of Sports Medicine. 2002; 36:370-373.
26. David C. Hughes, Stian Ellefsen, Keith Baar. Adaptations to Endurance and Strength Training. Cold Spring Harb Perpect Med. 2018; 8(6): a029769.
27. Loretta DiPietro, Physical Activity in Aging: Changes in Patterns and Their Relationship to Health and Function, The Journals of Gerontology: 2001; Series A, 56, Issue suppl_2, 13-22.
28. Iwamoto GA (2010) The role of the study of exercise in defining the Frontier of Integrative Biology. *Front. Physio.* 1:142.
29. Foteini Zervou, Nektarios A.M. Stavrou, Stefan Koehn, Katerina Zounhia, Maria Psychountaki | Andre Roca (Reviewing

Editor). Motives for exercise participation: The role of individual and psychological characteristics. Cogent Psychology. 2017; 4:1.
30. Pedro J Teixeira, Eliana V Carrraca, David Markland, Marlene N Silva, Richard M Ryan. Exercise, physical activity, and self-determination theory: A systematic review. Int J Behav Nutr Phys Act. 2012; 9: 78.
31. Karly Geller, Kate Renneke, Sarah Custer, Grace Tigue. Intrinsic and Extrinsic Motives Support Adults' Regular Physical Activity Maintenance. Sports Med Int Open. 2018; 2(3): E62-E66.
32. Anthony C. Hackney, Chapter 9 - Bottom Line: Why Should I Exercise?. Exercise, Sport, and Bioanalytical Chemistry, Elsevier, 2016, Pages 97-106.
33. Szychowska, A., Drygas, W. Physical activity as a determinant of successful aging: a narrative review article. Aging Clin Exp Res. 2022; 34, 1209 – 1214.
34. James S. Goodwin, Geriatrics and the Limits of Modern Medicine. N Engl J Med. 1999; 340: 1283-1285.
35. R.Vinodh Rajkumar. Facilitating accountable critical thinking (FACT): a perspective from a novel facet of critical medical anthropology. Galore International Journal of Applied Sciences & Humanities. 2022; 6(3): 1-12.

How to cite this article: R. Vinodh Rajkumar. Accurate interpretation of stability of human health and ageing trajectory through a single objective measure of homeostasis. *International Journal of Science & Healthcare Research.* 2022; 7(3): 120-129. DOI: *https://doi.org/10.52403/ ijshr.20220719*

******