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Review

Improvement prediction process prevent chronic diseases from environmental threat: Integration omics to decision process in quality of health

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Abstract

Health Surveillance evolves gradually by adopting an innovated model of detection, measurement, or prediction. Appreciation of disease is variable depending on diagnostic skills with detection platform and predictable outcomes. Due to the lack of precision tools and skills to predict signaling from environmental threat, human health is still struggling to build up a barrier due to challenging socio-economic factors that evaluate their sequelae differently based on disease status. Under the traditional infrastructure, it is determined that health management systems to prevent diseases by evaluating risk factors to different diseases, such as health behavioral assessments and risk define and validation steps, are developed on organs dependent on symptomatic progression or phenotypical change following up epidemiological assessment. By improving detection methodology in molecular aspects to predict pathogens and risk factor surrounding our environmental niche, health status could be managed by the development of a prediction science utilized molecular based concept and its application strategy like ways of transitional, translational and transformational to public health structure. In this study, we suggest that management skills and tools need to be renovated by integrating a categorized molecular-based detection system such as Omics strategy based on the targeting objective. In disease management under the architecture of public health, a harmful outcome can be predicted following algorism equipped with a processing module for handling big data on an individual, family, and community, and global health level. Disease pattern derived from a multilayer platform could be beneficial to predict vulnerability and sensitivity against environmental threats. Herein, we discuss the conventional method based on how environmental factors affect the health impedance or propensity of chronic diseases in the young (i.e., autism) and elder population (i.e., Alzheimer disease). There are substantial benefits to developing a prevention module to a community from big data collected from families or individuals. By examining this integrational challenge, the goal is to better approach global health burden locally and systematically, following risk consequences as a predictable pattern based on the process of regarding value evaluation step-wise, after molecular-based identification and validation.

Introduction

In spite of continuous efforts to explore disease prediction with innovative algorisms, the value of public health is still less evaluated, due to failure to detect disease infiltration to the community and the personal health impact of an environmental threat, or due to stress related to quality of health, which may affect the series of disease outbreak events due to unidentified risk factors or pathogen [1-4]. With regard to health management and surveillance between individual to population, it remains unclear how the environment influences genome encoding in human health. Currently, ways of prediction upon genetic disposition have developed to handle in various diseases, including mental disorder, developmental retardation, behavioral interruption, and metabolic alteration, which are investigated with post-determination strategy [5-7, 9]. The scope of the natural environment threat is inclusive of air, water, and soil, as well as all the physical, chemical, biological and

social features of our surroundings [3, 5, 6, 8]. There are also elements of the social environment such as lifestyle factors and socioeconomic status which can have an indirect effect on a person's health. All of these environmental components interact in unique ways with the quality of life and can inevitably end up compromising one's health status like phenotypic outcomes, disease being one of them. Under the current frame of disease prevention in public health, this branch functions to create and maintain safe and healthy working environments by identifying and controlling potential risks arising from pre-existing workplace hazards. Depending on the type of work or industry atmosphere, these hazards may be chemical or physical in nature such as heavy metals or pollutants, or internal hormonal interruption as by-product emotional sequelae [6, 10].

Current challenges of environmental health are within the realm of public health issues that include polluted air and water, poor waste management systems, as well as hazardous materials/toxic substances management, drug abuse, and food safety. Unfortunately, the risks have the potential to lead to more serious effects such as varying types of chronic diseases, for example: Alzheimer disease, Parkinson disease, Huntington disease, autism, PTSD, and autoimmune diseases [11-17]. Herein lies yet another public health burden. Biological and chemical toxins, contaminants, and even physical hazards within the environment, whether natural or occupational have the potential to cause health risks. The impact for the public health is immense, protecting community health and global health from an environmental threat, even though infectious disease continues to be problematic in many countries. Chronic diseases including autism and neurodegenerative diseases are the leading cause of death, along with mental disability globally resulting from mitochondria dysfunction. Inclusive of other related diseases are non-communicable health conditions such as heart and respiratory disease, cancer, and diabetes to name a few [18-21]. In order to ensure the health of the population, the only resolve for public health practitioners are to ascertain ways to prevent and control these.

Omics Predict the Disease Pattern by Targeting Molecules

Similar to systemic biology strategy in drug discovery for medicine, Omics technologies are differentiated multi-layer platforms for detecting disease trend with new biomarkers discovery and provide validation tools by which prediction can be applied to study big data impact of biological molecules and its role of health sustainability. Even though the number of omics techniques is increasing gradually, there are five major developed omics technologies: include epigenomics, transcriptomics, genomics, proteomics, lipidomes, and metabolomics [9, 22-28]. Genomics is focused on genomes, proteomics is studied large sets of protein detection, metabolomics deals with large sets of small molecules, transcriptomics focused on detection of mRNA expression, and lastly epigenomes deals with the epigenetic regulation of DNA and of histone expression including microRNAs production. An aspect of environmental and occupational health, combined Omics terminology can be defined as the study of the interactions between the environment (exposome derived from exposure and genomics), individual (genetic) susceptibility (epigenome) and biological outcomes (interactome), while pattern interpretation and recognition due to alteration of the biological outcomes is known as molecular determinants in the disease, as well as the important (preclinical) intermediate endpoint [29-33].

The application of omics technologies is worthy to develop in occupational environmental health research and public health which has had few applications of these technologies. To visualize the effect of stress on human health, Lee et al have reported the proteomics profile against stress was reprogrammed using Omics, protein- basis detection method. In particular, integrated human studies following exposure to environmental risk factors attributed to abnormalities in normal physiological functioning or phenotypic alteration in biological processes including neural network can be measured by means of objective indicators known as biomarkers utilize multi-dimensional Omics strategy [34-36].

Similar to the concept like Gene-environment interactions, molecular interaction from the environment to organelle contribute to complex disease development. In the study conducted by Yu et al. indicates that low-level copper and prevalent environmental exposures alter protein expression utilizes proteomics which contributes greatly to disease in AD [28].

Systematic risk evaluation of the majority of human chemical exposures had not been conducted, and it is the goal of regulatory agencies in the U.S. and worldwide. Recently, there has been recognition that toxicological approaches are more predictive of effects in humans for risk assessment; for example, in vitro human cell line data, pre-embryonic data, as well as animal data, are being used to identify toxicity mechanisms that can be translated into biomarkers which are relevant to human exposure studies. In this regard, the approach for big data to be targeted organ-specific with sensitivity and selectivity should be considered and would be beneficial to predicting chronic disease, and the mapping strategies generated from the use of Omics will serve as effective risk assessment tools to study exposure of human populations to environmental and occupational health pathogens or toxicants and their potential health effects. It suggests that Omics technologies can provide valuable information such as generating biomarkers of exposure, early effect, and/or susceptibility, elucidating mechanisms of action underlying exposure-related disease, and detecting a response at low doses. In previous studies, low-level and prevalent environmental exposures like lead exposure may have contributed greatly to disease predisposition; there is a need now to develop high-resolution technologies combined with validation tools like imaging systems in order to assess exposures interface from the environment (or molecule) and individuals (or body) to further understand regulatory connectivity on a structural level to the functional level, which will help to develop a better understanding of environment-health interactions by applying interactome, metabolome, and cellomics underlying various chemical prone disease-oriented network in the autism and neurodegenerative disorder [37-41].

Human Chronic Diseases Rooted from Mitochondria Impairment by Omics Application

It has been documented that exposure to particulates is associated with morbidity and mortality risks from many diseases, chronic illnesses and even cancer [5]. In disease states, cells may be affected in ways that alter function. The mitochondria are special organelles located within cells that contain their own DNA. They are essentially the powerhouse of the cell by producing ATP as a driving fuel for the cell. Interestingly the mitochondria are the focal point for medical diseases and ailments due to their sensitivity to environmental insult. It was demonstrated their connections between mitochondrial dysfunction and alteration of molecular networks, such as Parkinson disease, Alzheimer disease, Friedreich's ataxia, and autism [42-46].

Some of the occupational exposures to lead which may consider as a major threat to human health include mental intervention. Thus, lead is a pervasive public concern. Exposure to lead can occur in a variety ways, for example in the air, the soil, the water, through paint, glazed earthenware, lead piping, solder in food containers, automobile battery casings include welding and automobile radiator repair. The sensitive issue like lead-based paint still remains a major source of high-dose lead exposure for children in the United States [6].

In addition to ATP production, the mitochondria are also responsible for generating reactive oxygen species (ROS) which participate in cell signaling communications. They also regulate intracellular stores of calcium but if too much is absorbed the process can trigger apoptosis and prior studies have recognized that this occurrence in nerve cells may be contributory to Alzheimer disease [14]. Even though there is a growing body of evidence on the possibility of environmental causes having a role in the development of certain mitochondrial diseases, it is also known to be rooted in genetic causes in various organs which they are inherited from a few mutation of the parent chromosome in autism and Alzheimer disease [47, 48].

The combination of genetic predisposition and environmental exposure such as a chemical substance may create the right pathological circumstances for the development of the disease. For example, a specific mutation of mitochondria DNA combined with exposure to an aminoglycoside antibiotic increases the chances of deafness. Alcohol intake and smoking increase the likelihood and severity of vision loss in individuals afflicted with Leber hereditary optic neuropathy [49-52].

Mitochondria appear to be susceptible in a number of ways. Drug-induced toxicity of these vital cells can disrupt their electron transport chain and transport pathways, interfere with fatty acid oxidation, the citric acid cycle, as well as disturbing mitochondrial DNA replication and protein synthesis. It was found that the anti-cancer drug, adriamycin, acts by poisoning mitochondria resulting in ATP inhibition. This is because the drug has an affinity for cardiolipin which is found within the inner membrane of the mitochondria. [13] Pollutants or different toxicants can readily accumulate in mitochondrial membranes due to its high lipid content as seen with adriamycin. This facilitates the deposition of lipophilic compounds like polycyclic aromatic hydrocarbons and some alkylating agents. Toxic metals like mercury and lead have also been known to deposit in mitochondria as well [13].

In line with these, we also observed that low-level lead (Pb) exposure (0, 10 nM, 100 nM) insult mitochondria energy metabolism due to ROS production driven by oxidative stress using Flow cytometry on neuronal PC12 cells. In a cellular system, Lead mediated oxidative stress was determined by measuring ROS using quenching fluorescent dye DCF following Pb exposure for 4 hours in differentiated and undifferentiated PC12 cells along with H2O2 as the positive control. Mitochondria malfunction due to lead intoxication impaired anti-oxidant enzymes such as superoxide dismutase (Mn-SOD), glutathione S-transferase Mu 1 (GST-M1) and catalase. Furthermore, we determine the transcriptomic pattern of the gene interaction utilize PCR array system (Qiagen, CA). Our results indicate that several mitochondrial genes are affected by more than 10-fold up-regulation (i.e., Aifm2, cdkn2a, Tspo, Immp1, Sh3glb, stard3, etc) or 5-fold down-regulation (i.e., Hspd1, Slc25ac, Slc25a5) in the neuronal PC12 cells treated with a low dose of lead (10 nM). It suggests that low dosage of lead are harmful and insult neuronal cell death or promote cell apoptosis process which reflects mitochondrial dysfunction following oxidative stress (ROS) are associated with cellular defense and interrupt cells signaling cascade include alteration of regulatory molecule (peroxisome proliferator-activated receptors, PPARs), epigenetic modification (i.e., microRNA production), modification of receptors expression, and [Ca2+] reflux in the synaptic button (Kim et al., Unpublished data). It remains to be examined further the susceptible assessment to tissue level and functional defect in Animal model.

Omics Detect Environmental Intoxication Impact in Elderly Health Burden

Alzheimer's disease (AD) is a progressive neurodegenerative disease which occurs widespread during the aging process due to development of Amyloid Beta (Aβ) plaques and neurofibrillary tangles in the cortex and hippocampus legion. It brings about molecular interaction among macromolecules in the brain and among stressors from environmental risk, which may be evolving the impair scavenger system to reflect oxidative stress rooted from the environmental niche. Their presences constraints the normal signaling properties and will subsequently lead to learning and memory deficits. It manifests itself in the form of progressive memory loss which follows by gradual strain accomplishing normal activities. Late-onset Alzheimer's disease (LOAD) is the most common form of the AD which occurs at the age of 65 and above. Though the etiology of LOAD is multifarious which includes genetic factors, environmental risk factors also play an important role. In epidemiologic studies of adults, long-term Lead exposure has been linked with enhanced degeneration of cognition. Similarly, research in animal models proposed a causal relationship between Lead exposure even during early life and LOAD According to previous studies, Lead exposure is a risk factor for increased hippocampal gliosis - an abnormality associated with LOAD development [7, 53-55].

It is important to note that AD is not a result of an abrupt event but in fact may begin in early life considering their lifestyle, environmental exposures, and genetic traits. On rodents model, a study reported that early life exposure of

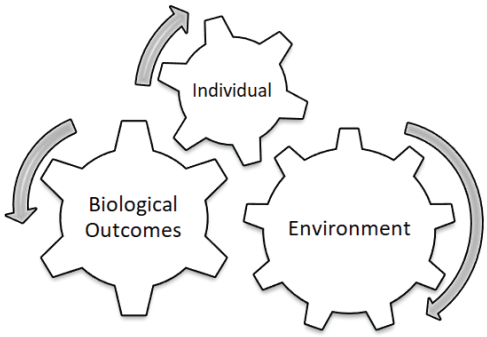

Figure 1. Combined Omics terminology.

rodents to Lead (Pb) heightened the expression of genes correlated with the AD, and boosted the burden of oxidative DNA damage in the aged brain [56, 57].

According to studies by the American Academy of Neurology (AAN), occupational Lead (Pb) exposure can considerably increase the risks of developing Alzheimer's disease. Other researchers believe that those with high dose and/or greater level of exposure to lead are 3.4 times more likely to develop Alzheimer's disease. Lead exposure is a substantial risk factor for enhanced deteriorations in human cognitive abilities [55]. In addition, numerous epidemiological studies have studied the impact of low dose lead exposure on children's cognition and have proposed a dose-response association among lead exposure and learning disabilities [28, 58-62].

Omics Strategy to Disease Prediction in Health Management

The scientific field of diagnostics and treatment skills is advancing quickly. Applications of Omics strategies incorporate the scientific platforms of genomics, transcriptomics, proteomics, and metabolomics. Through these disciplines, biomedical disease research is more comprehensive and definitive in which case the most appropriate therapeutic targets can be identified and utilized for the best health outcomes. Currently, predictive skills and tools in the field of public health and disease management are solely handling with the phenotypic data include human behavioral factors and economic trends. It is time to consider a new format in the disease process by examining multidimensional factors including human genome alteration.

Utilizing metabolomics may provide metabolic profiles and signatures for toxicity, disease, and therapeutic efficacy. In this regard, mitochondrial disorders will greatly benefit from the prognostic and diagnostic capacity of metabolomics research in chronic diseases [63-66]. Those afflicted with mitochondrial disorders among children will serve to benefit from Omics strategies in development and maximization of targeted treatments. Ultimately, the multiple biochemical and molecular techniques offered by the field of Omics will prove to be advantageous for the biomedical and public health communities.

Future Perspective in Quality of Health Care

Omics-implemented health management, maintenance, and surveillance systems may to human diseases range from the prenatal stage to aging population including unmet outcome like infectious disease such a global health injustice. Moreover, the implemental process needs the input of accumulating big data from genetic and phenotypic traits as personal health to predict human health intervention against environmental threats including stress in human behavioral change as well as functional alteration in cognitive aspects. In addition, Health advocacy regarding provisional prediction in which disease predisposition would be coupled with the translation process in structure and functional change on the genomic level result in the transformational outcomes in disease status. The challenge to an integrated application of three elements after combined genomic to proteomics may predict in behavioral change on population health as outcomes of interactomics in which standardized prediction process may accelerate development of validation cycle of prediction to prevention in human disease using Omics methodologies. Also, the Omics platform enables exploring for best resolution such as visualize efficacy profile per treatment options which may contribute to leveraging health cost and reduce medical cost in public health. In the future public health, Omics assisted program and restructure of evaluation play a role in the process of disease management after adopting new trend of prediction such as molecular-based architecture like translational public health. Omics platform contribute low rate of disease occurs due to achieve certain level of health goals like early prevention and effective diagnosis by generating big data handling in the range from personal to community, and population utilize molecular-based step-wise surveillance and risk management tools (i.e., define, detection, determine in molecular approach vs. prediction, prevention, promote in human health approach) have the potential to improve the quality of health care and alleviate disease propagation as a burden of public health.

Author Contribution

All authors have participated development of concept of predictability and structure of disease management along with multidimensional data collection as molecular based risk strategy utilize Omics strategy by reviewing evidenced based Omics application in clinic and research in animal models.

Disclosure

No conflicts of interest

References

1. Lane-deGraaf KE, Kennedy RC, Arifin SM, et al. A test of agent-based models as a tool for predicting patterns of pathogen transmission in complex landscapes. BMC Ecol. 2013;13:35.

2. Neri FM, Cook AR, Gibson GJ, Gottwald TR, Gilligan CA, et al. Bayesian analysis for inference of an emerging epidemic: citrus canker in urban landscapes. PLoS Comput Biol. 2014;10(4):e1003587
3. Wu X, Lu Y, Zhou S,. Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. Environ Int. 2016; 86:14-23.
4. Sinclair RC, Gershon RR, Murphy LR,. Operationalizing theoretical constructs in bloodborne pathogens training curriculum. Health Educ Q. 1996;23(2):238-55.
5. Kelishadi R. Environmental pollution: health effects and operational implications for pollutants removal. J Environ Public Health. 2012: 2012;341637.
6. Landrigan PJ. Occupational and community exposures to toxic metals: lead, cadmium, mercury and arsenic. West J Med. 1982; 137(6):531-9.
7. Thanan R, Oikawa S, Hiraku Y, et al. Oxidative stress and its significant roles in neurodegenerative diseases and cancer. Int J Mol Sci. 2014;16(1):193-217.
8. Barjaktarovic Z, Schmaltz D, Shyla A, et al. Radiation-induced signaling results in mitochondrial impairment in mouse heart at 4 weeks after exposure to X-rays. PLoS One. 2011;6(12):e27811.
9. Collins CD, Purohit S, Podolsky RH, et al. The application of genomic and proteomic technologies in predictive, preventive and personalized medicine. Vascul Pharmacol. 2006;45(5):258-67.
10. Cooper JD, Ozcan S, Gardner RM, et al. Schizophrenia-risk and urban birth are associated with proteomic changes in neonatal dried blood spots. Transl Psychiatry. 2017;7(12):1290.
11. Zolkipli-Cunningham Z, Falk MJ. Clinical effects of chemical exposures on mitochondrial function. Toxicology. 2017;391:90-99.
12. Meyer JN, Leung MC, Rooney JP, et al. Mitochondria as a target of environmental toxicants. Toxicol Sci. 2013;134(1):1-17.
13. Jenner P. Altered mitochondrial function, iron metabolism and glutathione levels in Parkinson's disease. Acta Neurol Scand Suppl. 1993;146:6-13
14. Gibson GE, Starkov A, Blass JP, et al. Cause and consequence: mitochondrial dysfunction initiates and propagates neuronal dysfunction, neuronal death and behavioral abnormalities in age-associated neurodegenerative diseases. Biochim Biophys Acta. 2010;1802(1):122-34
15. Ishii T, Takanashi Y, Sugita K, et al. Endogenous reactive oxygen species cause astrocyte defects and neuronal dysfunctions in the hippocampus: a new model for aging brain. Aging Cell. 2017;16(1):39-51.
16. Lodi R, Taylor DJ, Schapira AH. Mitochondrial dysfunction in friedreich's ataxia. Biol Signals Recept. 2001;10(3-4):263-70.
17. Bakulski KM, Rozek LS, Dolinoy DC, et al. Alzheimer's disease and environmental exposure to lead: the epidemiologic evidence and potential role of epigenetics. Curr Alzheimer Res. 2012;9(5):563-73.
18 Marín-García J, Goldenthal MJ. Understanding the impact of mitochondrial defects in cardiovascular disease: a review. J Card Fail. 2002;8(5):347-61.
19. Aguilera-Aguirre L, Bacsi A, Saavedra-Molina A, et al. Mitochondrial dysfunction increases allergic airway inflammation. J Immunol. 2009;183(8):5379-87.
20. Weinhouse C. Mitochondrial-epigenetic crosstalk in environmental toxicology. Toxicology. 2017;391:5-17.
21. Mantena SK, King AL, Andringa KK, et al. Mitochondrial dysfunction and oxidative stress in the pathogenesis of alcohol- and obesity-induced fatty liver diseases. Free Radic Biol Med. 2008;44(7):1259-72.
22. Filiou MD, Zhang Y, Teplytska L, et al. Proteomics and metabolomics analysis of a trait anxiety mouse model reveals divergent mitochondrial pathways. Biol Psychiatry. 2011;70(11):1074-82.
23. Guda P, Subramaniam S, Guda C. Mitoproteome: human heart mitochondrial protein sequence database. Methods Mol Biol. 2007;357:375-83.
24. Prokisch H, Andreoli C, Ahting U, et al. MitoP2: the mitochondrial proteome database--now including mouse data. Nucleic Acids Res. 2006;34(Database issue):D705-11.
25. Plass C, Byrd JC, Raval A, et al. Molecular profiling of chronic lymphocytic leukaemia: genetics meets epigenetics to identify predisposing genes. Br J Haematol. 2007;139(5):744-52.
26. Jungnickel H, Tentschert J, Luch A. Monitoring oxidative stress biomarkers in the lipidome: is there a roadmap for "human inspection"? Curr Mol Med. 2012;12(6):716-31
27. Go YM, Roede JR, Orr M, et al. Integrated redox proteomics and metabolomics of mitochondria to identify mechanisms of cd toxicity. Toxicol Sci. 2014;139(1):59-73.
28. Yu H, Wang D, Zou L, et al. Proteomic alterations of brain subcellular organelles caused by low-dose copper exposure: implication for Alzheimer's disease. Arch Toxicol. 2018;92(4):1363-1382.
29. Wild CP, Scalbert A, Herceg Z. Measuring the exposome: a powerful basis for evaluating environmental exposures and cancer risk. Environ Mol Mutagen. 2013;54(7):480-99
30. Coughlin SS. Toward a road map for global -omics: a primer on -omic technologies. Am J Epidemiol. 2014;180(12):1188-95.
31. Holland N. Future of environmental research in the age of epigenomics and exposomics. Rev Environ Health. 2017;32(1-2):45-54.
32. Carter CJ. Susceptibility genes are enriched in those of the herpes simplex virus 1/host interactome in psychiatric and neurological disorders. Pathog Dis. 2013;69(3):240-61.
33. Sookoian S, Pirola CJ. Genetic determinants of acquired cholestasis: a systems biology approach. Front Biosci (Landmark Ed). 2012;17:206-20.
34. Qureshi IA, Mehler MF. Understanding neurological disease mechanisms in the era of epigenetics. JAMA Neurol. 2013;70(6):703-10.
35. Haase L, Wang M, Green E, et al. Functional connectivity during recognition memory in individuals genetically at risk for Alzheimer's disease. Hum Brain Mapp. 2013;34(3):530-42
36. Spencer KL, Olson LM, Schnetz-Boutaud N, et al. Using genetic variation and environmental risk factor data to identify individuals at high risk for age-related macular degeneration. PLoS One. 2011 6(3):e17784.
37. Morgan JT, Chana G, Abramson I, et al. Abnormal microglial-neuronal spatial organization in the dorsolateral prefrontal cortex in autism. Brain Res. 2012;1456:72-81.
38. Urinary metabolomics of young Italian autistic children supports abnormal tryptophan and purine metabolism.
39. Gevi F, Zolla L, Gabriele S, et al. Urinary metabolomics of young Italian autistic children supports abnormal tryptophan and purine metabolism. Mol Autism. 2016;7:47.
40. Herminghaus S, Frölich L, Gorriz C, et al. Brain metabolism in Alzheimer disease and vascular dementia assessed by in vivo proton magnetic resonance spectroscopy. Psychiatry Res. 2003;123(3):183-90.
41. Modrego PJ, Pina MA, Fayed N, et al. Changes in metabolite ratios after treatment with rivastigmine in Alzheimer's disease: a nonrandomised controlled trial with magnetic resonance spectroscopy. CNS Drugs. 2006;20(10):867-77.
42. Shi G, Lee JR, Grimes DA, et al. Functional alteration of PARL contributes to mitochondrial dysregulation in Parkinson's disease. Hum Mol Genet. 2011;20(10):1966-74.
43. Manczak M, Park BS, Jung Y, et al. Differential expression of oxidative phosphorylation genes in patients with Alzheimer's disease: implications for early mitochondrial dysfunction and oxidative damage. Neuromolecular Med. 2004;5(2):147-62.
44. Gille G, Reichmann H. Iron-dependent functions of mitochondria--relation to neurodegeneration. J Neural Transm (Vienna). 2011 Mar;118(3):349-59.
45. Zeidán-Chuliá F, de Oliveira BH, Salmina AB, et al. Altered expression of Alzheimer's disease-related genes in the cerebellum of autistic patients: a model for disrupted brain connectome and therapy. Cell Death Dis. 2014;5:e1250.
46. Napoli E, Wong S, Hertz-Picciotto I, et al. Deficits in bioenergetics and impaired immune response in granulocytes from children with autism.

Pediatrics. 2014;133(5):e1405-10.
47. Haas RH. Autism and mitochondrial disease. Dev Disabil Res Rev. 2010;16(2):144-53.
48. Wallace DC. Mitochondrial DNA sequence variation in human evolution and disease. Proc Natl Acad Sci U S A. 1994;91(19):8739-46.
49. Bitner-Glindzicz M, Rahman S, Chant K, et al. Gentamicin, genetic variation and deafness in preterm children. BMC Pediatr. 2014;14:66.
50. Shen Z, Zheng J, Chen B, et al. Frequency and spectrum of mitochondrial 12S rRNA variants in 440 Han Chinese hearing impaired pediatric subjects from two otology clinics. J Transl Med. 2011;9:4.
51. Korkiamäki P, Kervinen M, Karjalainen K, et al. Prevalence of the primary LHON mutations in Northern Finland associated with bilateral optic atrophy and tobacco-alcohol amblyopia. Acta Ophthalmol. 2013;91(7):630-4.
52. La Morgia C, Achilli A, Iommarini L, et al. Rare mtDNA variants in Leber hereditary optic neuropathy families with recurrence of myoclonus. Neurology. 2008;70(10):762-70.
53. Fan QY, Ramakrishna S, Marchi N, et al. Combined effects of prenatal inhibition of vasculogenesis and neurogenesis on rat brain development. Neurobiol Dis. 2008;32(3):499-509.
54. Baranowska-Bosiacka I, Listos J, Gutowska I, et al. Effects of perinatal exposure to lead (Pb) on purine receptor expression in the brain and gliosis in rats tolerant to morphine analgesia. Toxicology. 2016;339:19-33.
55. Shih RA, Hu H, Weisskopf MG, et al. Cumulative lead dose and cognitive function in adults: a review of studies that measured both blood lead and bone lead. Environ Health Perspect. 2007 Mar;115(3):483-92.
56. Zawia NH, Lahiri DK, Cardozo-Pelaez F. Epigenetics, oxidative stress, and Alzheimer disease. Free Radic Biol Med. 2009;46(9):1241-9.
57. Bihaqi SW, Zawia NH. Enhanced taupathy and AD-like pathology in aged primate brains decades after infantile exposure to lead (Pb). Neurotoxicology. 2013;39:95-101.
58. Lanphear BP, Dietrich K, Auinger P, et al. Cognitive deficits associated with blood lead concentrations <10 microg/dL in US children and adolescents. Public Health Rep. 2000;115(6):521-9.
59. Mazumdar M, Bellinger DC, Gregas M, et al. Low-level environmental lead exposure in childhood and adult intellectual function: a follow-up study. Environ Health. 2011;10:24.
60. Wright RO, Tsaih SW, Schwartz J, et al. Lead exposure biomarkers and mini-mental status exam scores in older men. Epidemiology. 2003;14(6):713-8.
61. Fulton M, Raab G, Thomson G, et al. Influence of blood lead on the ability and attainment of children in Edinburgh. Lancet. 1987;1(8544):1221-6.
62. Pizzol M, Thomsen M, Frohn LM, Andersen MS. External costs of atmospheric Pb emissions: valuation of neurotoxic impacts due to inhalation. Environ Health. 2010;9:9.
63. Mussap M, Noto A, Fanos V. Metabolomics of autism spectrum disorders: early insights regarding mammalian-microbial cometabolites. Expert Rev Mol Diagn. 2016;16(8):869-81.
64. Janečková H, Hron K, Wojtowicz P, et al. Targeted metabolomic analysis of plasma samples for the diagnosis of inherited metabolic disorders. J Chromatogr A. 2012;1226:11-7.
65. Saykin AJ, Shen L, Yao X, et al. Genetic studies of quantitative MCI and AD phenotypes in ADNI: Progress, opportunities, and plans. Alzheimers Dement. 2015;11(7):792-814.
66. Sharma K, Karl B, Mathew AV, et al. Metabolomics reveals signature of mitochondrial dysfunction in diabetic kidney disease. J Am Soc Nephrol. 2013;24(11):1901-12.

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