PROCEEDING

Stress and nutrition in relation to excess development of chronic disease in Puerto Rican adults living in the Northeastern USA

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Abstract : Although health disparities are well documented among minority populations, they have not been fully explained by socio-economic status. We have demonstrated that Puerto Rican elders in Massachusetts are significantly more likely to have physical disability, depression, cognitive impairment, diabetes and other chronic health conditions than do non-Hispanic white elders living in the same neighborhoods. This suggests that the disparity is not due only to physical or neighborhood location, and that other factors must be influencing these differences. In that study, we also showed that the Puerto Rican elders had diets that were limited in diversity and were relatively low in micronutrient content. In our ongoing cohort study within our Boston Puerto Rican Center for Population Health and Health Disparities, we are investigating the relationships between psychosocial stress, its effect on physiologic burden or "allostatic load" and, in turn, how this is associated with the functional outcomes previously identified as areas of health disparity:depression, cognitive impairment and functional limitation. We further propose that the association between life stress, physiologic response and chronic conditions is modified by nutritional status, with a focus on B vitamins and antioxidant vitamins. J. Med. Invest. 52 Suppl. :252-258, November, 2005

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The US National Institutes of Health (NIH) have proposed a mission to improve the nation's health by uncovering new knowledge in the prevention, detection, diagnosis, and treatment of disease and disability, with the ultimate goal of reducing and eliminating health disparities among racial and ethnic minorities (1, 2). Although health disparities are well documented among minority populations, they have not been fully explained by socio-economic status. In a previous study funded by the National Institute on Aging (NIA) we have demonstrated that Puerto Rican elders in Massachusetts are significantly more likely to have physical disability, depression, cognitive impairment, diabetes and other chronic health conditions than do non-Hispanic white elders living in the same neighborhoods (3, 4). This suggests that the disparity is not due only to physical or neighborhood location, and that other factors must be influencing these differences. In that study, we also showed that the Puerto Rican elders had diets that were limited in diversity and were relatively low in micronutrient content.

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THE BOSTON PUERTO RICAN CENTER FOR POPULATION HEALTH AND HEALTH DISPARITIES

In our ongoing cohort study within our Boston Puerto Rican Center for Population Health and Health Disparities, we are investigating the relationships between psychosocial stress, its effect on physiologic burden or "allostatic load" and, in turn, how this is associated with the functional outcomes previously identified as areas of health disparity : depression, cognitive impairment and functional limitation. We further propose that the association between life stress, physiologic response and chronic conditions is modified by nutritional status, with a focus on B vitamins and antioxidant vitamins.

As part of our Center activities, we are performing a series of studies involving a cohort of Hispanic adults of Puerto Rican origin to evaluate specific stressors affecting the community, and to determine the effect of these stressors on disease specific outcomes. We evaluate physiologic measures of stress related variables, measures of factors related to acculturation and immigration, vitamin intake and blood concentrations, assess physiological response through measures of allostatic load, and assess measures of cognitive and physical function. Having already clearly demonstrated that health disparities exist in this population relative to neighborhood matched non-Hispanic white older adults, we are now testing the overall hypothesis that within this ethnic minority group, variation in stress, associated with poverty, migration, acculturation and perceived discrimination, leads to greater allostatic load, and subsequently to adverse health outcomes, including depression and physical and cognitive impairment. We further hypothesize that low vitamin intake and status accelerates this progression from stress to disability ; that these associations are modified by genetic variability ; and that markers of inflammation can contribute to understanding these mechanisms.

The Center includes an integrated set of four research projects and three support cores (Figure 1). The centerpiece is a longitudinal cohort study to examine associations between stress, nutrition and chronic health conditions. The other projects build from this cohort, so that information can be shared across a spectrum from community and sociologic understanding to biological mechanism. These inter-related projects include :

1) We are investigating both baseline and two year prospective associations between psychosocial stressors and "allostatic load ; and in turn, allostatic load and functional decline, specifically depression, cognitive decline and physical disability ; along with the role of vitamin intake and status in modifying these associations among a cohort of 1200 Puerto Rican adults aged between 50 and 70 years at baseline.

2) A sociological investigation examines psychosocial stressors and their measurement. Using both qualitative and quantitative methodology, we gain contextual understanding of the sources of stress in this population that relate to allostatic load, and continue to adapt instruments for its measurement.

3) We have two intervention studies, using subsets of the baseline study, through which we are investigating the effectiveness of two-year interventions for reducing indicators of allostatic load. Each is designed to be feasible for expansion by community agencies if effective. These include : 1) vitamin supplementation ; and 2) social support and participation.

4) We are also exploring the relationship between selected gene variants and allostatic load, at baseline and with change over time ; as well as the interaction between gene variants and responses to the differing nutrition and social interventions.

In order to efficiently serve these integrated research projects, we coordinate data collection and processing through three Core facilities : an administrative core, a statistics core and a laboratory core. The administrative core serves as the main coordinating center for budget related issues, report preparation, field operations, intercommunication between projects and investigators, organization of meetings, and a pilot projects program. The statistics core receives all data, assures its quality and confidentiality and assists with statistical design and analysis. The laboratory core is responsible for the processing of laboratory samples (blood and urine) for all projects.

BACKGROUND AND SIGNIFICANCE

There are gradients of health that exist beyond socioeconomic status (SES), income, and education that remain elusive. Studies have shown that ethnic minority status is associated with psychological stresses related to linguistic differences, changing personal and family values, role expectations, lower socioeconomic conditions, immigrant status, and perceived discrimination (5). Accumulation of these stressors may have deleterious effects on health and longevity. It is important to identify and explore variables contributing to health disparities and identify to what extent psychological stressors impact disease

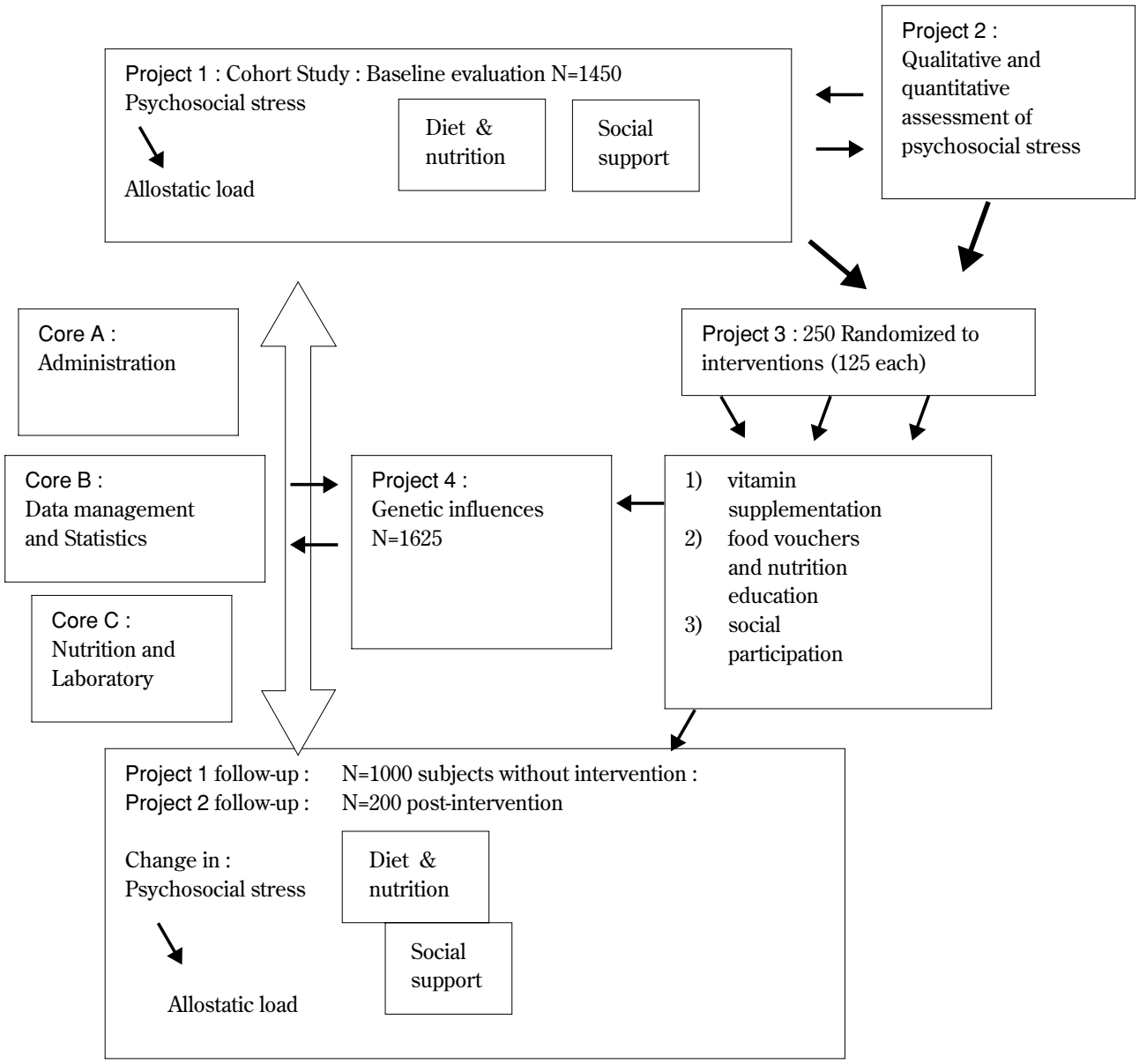

Figure 1 The Boston Puerto Rican Center on Population Health and Health Disparities : Inter-relationships between projects and cores

outcome, primarily physical and cognitive functioning, cardiovascular disease, diabetes, and obesity.

Cultural and ethnic minorities tend to face more stressors quantitatively and qualitatively than the majority population (5). These stressors, developing from discrimination, financial stresses, changes in family relationships and dynamics, and removal of community and social support system lead to physiological and psychological adaptations that can potentially result in an increased prevalence of disease (6, 7). Social and behavioral science has documented certain cultural and ethnic variations in processes involved in coping with stress, e.g., cognitive, emotional, and social processes ; perception of self, and motivation. It is essential to determine the extent to which cultural or ethnic groups react to and cope with stress differently in order to develop more comprehensive intervention programs aimed at reducing health disparities.

Physiologic adaptation to stressful events or challenges involves activation of neural and neuroendocrine-immune mechanisms. The manifestation of biologic responses to stressful challenges has been termed "allostasis" (8). "Allostatic load" has been proposed as a conceptualization of cumulative biological burden exacted on the body through attempts to adapt to daily physical and emotional stress (9). Because members of ethnic minorities have been shown to experience greater than average levels of a variety of stressors throughout their life, resulting allostatic load is thought to contribute to an observed excess risk for a variety of health conditions (9-12).

Allostatic load has been proposed as a new conceptualization of cumulative biological burden exacted on the body through attempt to adapt to daily physical and emotional stress. A summary measure of this load, based on 10 parameters of biological functioning, includes 1) the hypothalamic-pituitary-adrenal (HPA) axis (serum dehydroepiandrosterone sulfate (DHEA-S) and 12 hour urinary cortisol excretion), 2) sympathetic nervous system (12 hour urinary norepinephrine and epinephrine excretion), 3) cardiovascular system (systolic and diastolic blood pressure, serum high-density lipoprotein (HDL) and total cholesterol concentrations), and metabolic processes (plasma glycosylated hemoglobin) ; and waist/hip ratio).

A number of studies have linked increased levels of allostatic load to an increased risk of morbidity and mortality (12). Several factors involved in the mediation of allostasis and allostatic load include learned behavior, such as diet, exercise, smoking, and drinking. These factors affect the reactivity of regulatory systems that produce stress mediators. Data on the association between diet, nutrient status and allostatic load are extremely limited. However, studies have shown that poor nutrient status has been linked to immunosuppression and subsequent disease proliferation.

Under conditions of high stress, individuals consume significantly more dietary fat and fewer micronutrients (13). Diets high in saturated fat and low in vitamins and minerals have been linked to increased morbidity and mortality. Studies have shown that habitual consumption of high-glycemic index foods may increase risk for obesity, type 2 diabetes, and heart disease (14). We hypothesize that vitamins and antioxidants may help ameliorate allostatic load through targeting specific components of the physiologic burden of stress. Results from the DASH study indicated that measures of plasma vitamin C were inversely correlated with diastolic blood pressure within 30 days (15-17). Individuals in the lowest Vitamin C group had the highest blood pressure. Results from this study support the hypothesis that low intake of antioxidant-rich fruits and vegetables may be one of the causes of hypertension, however the mechanism remains elusive (17). Research has indicated that these antioxidants may exert their beneficial effects by preventing or retarding various steps in atherogenesis by inhibiting oxidation of low-density lipoprotein and other free radical reactions (18-20). Existing relationships between chronic conditions and nutritional status of the elderly support the likelihood that nutrition influences the development of disability, through effects on diabetes, obesity, hypertension, and mood disorders, vascular disease, and cognitive impairment. Allostatic load may adversely affect nutrient status through dietary inadequacy, which in turn, may increase the effects of the allostatic load due to immunosuppression and impairment of regulatory systems, contributing to a greater physiological burden manifesting in a more significant disease burden and greater impairment in daily activities.

Epidemiological studies indicate that those who are financially disadvantaged have higher rates of morbidity and mortality resulting from physical and mental disorders, anxiety, substance abuse disorders, yet racial differences in mental health status persist even at equivalent levels of socio-economic status (2). Disease burden associated with mental disorders and associated risk factors for mental disorders falls disproportionately on ethnic minority populations.

The total elderly population in MA is projected to increase from 14.2% in 1995 to 18.2% in 2025 (21). Among these, the greatest increases will be seen among Hispanics, with an expected to increase from 6% of the total elderly population in 1996 to 9% by 2025. A report of 1990 National Census data found that 30% of Puerto Rican families were living in poverty, compared with 10% of non-Hispanic families (22). Among Puerto Ricans in HHANES, 32% of males and 50% of females aged 55-74 years were living below the poverty line. Puerto Ricans report the worst health status and the highest rate of acute medical conditions and chronic conditions, which limit major activities, when compared with non-Hispanic whites and other major Hispanic subgroups (23).

Many studies have shown adverse effects of stress related to immigration and acculturation on mental health status in Hispanics in the United States, however, none of these studies have taken into account changes in dietary intake and micronutrient status as variables in the outcomes studied. Our Center has been designed to address the critical and necessary component of micronutrient status, dietary adequacy, and health related behaviors in the assessment of disease specific outcomes as related to acculturation and migration in a Hispanic community.

PRELIMINARY STUDIES

We have documented extensive health disparities in this Puerto Rican population in relation to neighborhood based non-Hispanic white elders. In a representative sample of Hispanics aged 60 and above,

living in the state of Massachusetts, we found that Puerto Ricans, who make up the majority of the Hispanic population, were the most disadvantaged subgroup. On average they had completed 5 years of formal schooling and 57% had household incomes that fell below federal poverty guidelines. Puerto Rican elders had significantly higher disability scores than did neighborhood based non-Hispanic whites. Fifty-six percent of men and 73% of women reported some difficulty with at least one activity of daily living (ADL), and 19% of men and 27% of women reported that they could not do at least one ADL. Major ADL difficulties were associated with climbing stairs and getting outside. More than 22% of men and 32% of women reported that they could not do at least one IADL. Of these, the most common limitations were with housework and shopping (3). Thirty-eight percent of these Puerto Rican elders had diabetes, assessed by glucose and/or use of diabetes medication relative to 23% of non-Hispanic white elders. Among those with diabetes, Puerto Ricans were more than twice as likely to have high glycosylated hemoglobin (>7%) indicating poor control (4). Diabetes was significantly associated with poor nutritional status as indicated by low serum albumin, and also with ADL difficulty (24). Twenty nine percent of men and 36% of women were obese (BMI $\geq$ 30) and 42% of men and 74% of women had central obesity defined as waist circumference >102 cm and 88 cm, respectively. Larger waist circumference was associated with both diabetes (25) and greater ADL score (26). Sixty-six percent of men and 75% of women had hypertension and systolic hypertension was significantly more prevalent among Puerto Ricans relative to non-Hispanic whites (27). Furthermore, despite similar reports of treatment, significantly fewer Puerto Ricans with hypertension had their hypertension under control relative to non-Hispanic whites (39 vs 57%). More than 44% had depressive symptomatology, based on CES-D scores $\geq$ 16, double that of non-Hispanic white elders (22%), and CES-D score was significantly associated with being female, living alone, number of reported health conditions, having lower education, lower income, and lower use of English language (less acculturated) (28). Puerto Ricans were significantly more cognitively impaired than non-Hispanic white elders ; 53% of Hispanics relative to 15% of non-Hispanic whites had MMSE scores <23 (29). This Hispanic group also had significantly lower nutritional status as measured by dietary and plasma folate (29, 30), vitamin B12 (31), vitamin E (32) and carotenoids (33). Plasma pyridoxyl-5'-phosphate (vitamin B6) was significantly associated with depression in this group (34). Folate and vitamin B6 from both diet and plasma were significantly associated with score on a story recall test (29).

Our experience in the homes and with limited ethnographic interviews suggested that the living situation for many of these Puerto Rican elders is quite difficult. Given stereotypic expectations of family support in the Latino community, it is notable that we found that 37% were, in fact, living alone. In their discussions with us, they complained of problems with children that included drug use and incarceration and in some cases use of their small amount of funds. Many were left with grandchildren to care for. Based on that experience and the data we observed on evidence of excess prevalence of high component measures of allostatic load and excess prevalence of chronic conditions and disability, a more focused examination of sources of psychosocial stress along with systematic measurement of allostatic load is needed. Furthermore, a longitudinal component will assist in clarifying the directionality of these associations. The addition of genetic markers and a better understanding of the role of inflammation will offer additional understanding of these processes. Finally, trial interventions will provide guidance on ways to reduce the health disparities and to improve the health and well being of this growing and underserved segment of the US society.

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