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Ecological correlations of dietary food intake and mental health disorders

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Abstract This paper examines the ecological association of dietary food intake with mental health outcomes on the group level across countries. Published data from the World Mental Health Survey were used to compare lifetime prevalence of four categories of mental health disorders (anxiety disorders, mood disorders, impulse control disorders, and substance use disorders) with a country's fish/seafood and sugar/sweetener supply quantity using the Spearman rank correlation. Data were compared for 17 countries across the world. Sugar and sweetener supply quantity was significantly and positively associated with anxiety disorders ($\rho = 0.75$, $p = 0.001$), mood disorders ($\rho = 0.75$, $p = 0.001$), impulse control disorders ($\rho = 0.78$, $p = 0.001$), and substance use disorders ($\rho = 0.68$, $p = 0.007$). Fish and seafood supply quantity had no significant association with any mental health disorders. Mental health disorders represent a significant health problem around the world. Public health measures aimed at improving the quality and availability of a nation's food supply could have a significant positive impact on mental health. Further randomized studies are needed to further validate the study findings.

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1. Introduction

Total expenditure on health as a percentage of a nation's gross domestic product from 2000 to 2011 has greatly increased [1]. The greatest single contributor to public health expenditure is expected to come from mental illness. At an estimated 16.3 trillion US dollars in 2010 worldwide,

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mental illness will cost more than cardiovascular disease, and also more than cancer, diabetes, and chronic respiratory diseases combined [2]. Therefore, focusing public health attention on methods of enhancing mental health is of critical importance. Diet plays a role in virtually every major disease category [3–6], including mental health [7–12]. While dietary interventions on mental illness could be simple, cost-effective public health measures, their implementation is still limited by a lack of research indicating the context and populations in which these interventions might be most effective [10–12].

The external validity of studies monitoring the effect of various dietary interventions on contextual populations is only as great as the sample is representative. Although many studies, including those cited throughout this paper, describe various means through which diet can improve mental health in a given country, the results and conclusions of these studies cannot be rigorously applied to other countries. Examples of ecological effects that may indirectly impact mental health can include different cultural, political, and economic environments, among other factors. Only a global study can provide the contextual rigor needed to drive public health policy across the globe. This paper therefore examines two elements of the diet that may have an impact on mental health: one considered beneficial (fish/seafood), and one considered detrimental (sugars/sweeteners).

Fish and seafood is the major source of two of the three omega-3 fatty acids, or *n*-3 polyunsaturated fatty acids (PUFAs), in human physiology [13]. PUFAs, particularly *n*-3 PUFAs, play a critical role in maintaining brain function. When compared to rats fed on a control base diet, rats supplemented with the *n*-3 PUFA of 10% cod liver oil for 20 days showed an increase in cortex levels of serotonin and dopamine, the two most targeted neurotransmitters for psychiatric illnesses [14]. Clinical evidence supports the use of PUFAs in treating depression. A meta-analysis of randomized controlled trials in humans suggests that a diet including omega-3 fatty acids is beneficial for treating depressive symptoms [15]. However, the evidence for studies assessing the impact of PUFA supplementation on other mental health disorders is weak [16].

The impact of sugar on mental functioning is varied. Sugar is a key factor in mental functioning insofar as it is the almost exclusive energy source of the brain, and as such can improve short-term cognition [17,18]. However, chronic sugar consumption appears to produce opposite effects on

cognition. Although rodent experiments have limited external validity for human studies, a systematic review of rodent studies showed that chronic sugar consumption led to cognitive impairments. Many of these studies used sugar levels that approximate the typical human consumption of about 5–20% of energy from added sugars [19]. In human studies, while sugar supplementation can improve children's cognitive scores in areas where breakfast sugar intake is inadequate [20], a review found that the Western diet, characterized by excessive saturated fats and refined sugars, is associated with poorer brain function [21].

Besides cognition, mental health is adversely affected by excessive chronic sugar intake. While diabetes mellitus has been longitudinally associated with major depressive disorder (MDD) and generalized anxiety disorder (GAD) [22,23], these psychiatric conditions may predate the onset of insulin resistance, which is the hallmark of diabetes. The impact of sugar on mental health may be more directly mediated through reward pathways of the brain than through strictly metabolic functioning [24–27]. Four studies of soft drinks found an association of increased consumption with increased mental health burden, two of which focused on adolescents [28,29], one on young adults [30], and one on the general adult population [31]. Furthermore, Australian adolescents consuming a "Western" diet were found to have higher rates of ADHD than those on a "healthy" diet [32].

This study has two aims. We investigate whether there is any association between fish/seafood consumption and mental health, particularly mood disorders, on the group level across countries. We also investigate whether there is any association between sugar/sweetener consumption and mental health on the group level across countries.

2. Materials and methods

2.1. Study design

This was a secondary data analysis comparing public domain data on food supply with published data on mental health disorder epidemiology.

2.2. Food supply quantity

As data on national-level food consumption is very challenging to collect, apparent food consumption is measured through food supply quantity under the assumptions of supply and demand. Public data for fish/seafood supply and sugar/sweetener supply quantity were extracted from the statistics division

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