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SHORT COMMUNICATION

Impact of Job Types on Plasma Neurotrophins Levels: A Preliminary Study in Airline Pilots, Construction Workers, and Fitness Instructors

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Abstract

BACKGROUND: Neurotrophins (NTs) encompass a group of closely associated proteins regulating various aspects of neuronal growth and survival. The potential association between work-related factors and the levels of circulating NTs has not been extensively examined. In this preliminary investigation, we evaluated plasma concentrations of brain-derived neurotrophic factor (BDNF), nerve growth factor (NGF), neurotrophin-3 (NT-3), and neurotrophin-4 (NT-4) in a cohort of healthy individuals from three distinct professional categories, each with unique work environments and lifestyle factors.

METHODS: The study involved 60 men from three professional fields: airline pilots, construction laborers, and fitness trainers (20 participants per category) recruited during routine occupational health appointments. Plasma levels of NTs were measured using commercially available immunoassays and compared in the three professional groups.

RESULTS: Among the professions studied, fitness instructors displayed the highest concentrations of BDNF and NGF, with airline pilots ranking second, and construction workers showing the lowest levels. Significantly decreased NT-3 levels were observed in airline pilots compared to fitness instructors and construction workers, but no differences were found between the latter two occupations. NT-4 levels were similar across all three occupational groups.

CONCLUSIONS: Our pilot results suggest that plasma concentrations of NTs, which are involved in various aspects of neuronal and cognitive functioning, may display significant differences among healthy individuals depending on their occupation. These observations warrant additional research to explore potential implications for the field of occupational medicine.

INTRODUCTION

Neurotrophins (NTs) serve as vital proteins that govern the growth and functionality of the nervous system (Dechant & Neumann, 2002). The four primary NTs – brain-derived neurotrophic factor (BDNF), nerve growth factor (NGF), neurotrophin-3 (NT-3), and neurotrophin-4 (NT-4) – are secreted by an array of cell types, including neurons and glial cells, and can be reliably identified in peripheral samples like serum or plasma (Huang & Reichardt, 2001). Consequently, they offer valuable insights into an individual's neural health and performance (McPhee *et al.* 2020). The possibility of neurotrophic factors playing a role in stress-related disorders has been proposed through the neurotrophic model, which suggests that stress, anxiety, and depression can lead to reduced NTs levels (Duman & Monteggia, 2006). However, there is also evidence showing that non-psychological factors, including physical exercise (Lippi *et al.* 2020) and metabolic health (Geroldi *et al.* 2006; Podyma *et al.* 2021; Iu & Chan, 2022), can affect NTs concentrations. Occupational factors such as job stress, particular job exposures, physical activity, and shift work might impact an individual's neuronal health and function (Then *et al.* 2014; Oltmanns *et al.* 2017; Garbarino *et al.* 2022). However, there is limited information on circulating NTs levels among various professional groups. Prior research in the field of occupational medicine has predominantly focused on job stress, but the findings have been, to some extent, inconsistent. Mitoma *et al.* (2008) have proposed using serum BDNF levels as a potential biomarker for psychological job stress in healthy workers, citing a negative correlation between serum BDNF levels and stress item scores. Moreover, another study discovered links between burnout symptoms and reduced serum BDNF levels in healthy individuals, with similar findings observed in employees diagnosed with clinical burnout (He *et al.* 2017). Sjörs Dahlman *et al.* (2019) found that individuals suffering from job stress-related exhaustion disorder displayed reduced plasma BDNF levels. In contrast, Buselli *et al.* (2019) reported divergent findings, demonstrating elevated plasma BDNF concentrations in employees subject to occupational stress and managing adjustment disorders, which were interpreted as a compensatory response.

Airline pilots, construction workers, and fitness instructors belong to three distinct professional categories, each characterized by unique work environments and lifestyle factors. As humans evolved as land-dwelling mammals, they encounter specific challenges in aviation that can have negative effects on their well-being (Arora, 2017). Airline pilots face various issues, including exposure to cosmic radiation, disruptions in sleep patterns and circadian rhythms, fatigue, psychological stress, and factors related to the cabin environment such as noise, vibration, and air quality (Minoretti & Emanuele, 2023). Additionally, irregular meal times and the sedentary nature of their job further contribute to work-related challenges. Interestingly, research has indicated a higher prevalence of cardiovascular disease and melanoma among pilots compared to the general population (Minoretti & Emanuele, 2023). In contrast, construction workers face a different set of challenges primarily related to physically demanding labor. Their work often involves operating machinery, lifting heavy objects, and performing tasks in extreme weather conditions. Moreover, they are frequently exposed to hazardous environmental contaminants, such as harmful chemicals, which pose significant long-term health risks (Boal *et al.* 2020). On the other hand, fitness instructors generally enjoy the benefits of regular physical activity and tend to adopt healthier lifestyles (Melton *et al.* 2008). As they guide clients through exercise routines, they actively engage in consistent workouts themselves, promoting cardiovascular health, muscle strength, and overall well-being. Moreover, the emphasis on fitness in their professional lives frequently guides them towards making healthier food selections, skillfully handling stress, and achieving a harmonious work-life balance.

Taking into account the various facets of their professional lives, we investigated the potential differences in plasma NTs levels among airline pilots, construction workers, and fitness instructors. To evaluate our hypothesis that circulating neurotrophic factors may vary depending on job types in healthy individuals, we carried out a preliminary cross-sectional study, which may have implications in the field of occupational medicine.

MATERIALS AND METHODS

Study population

A convenience sample consisting of 60 male participants was selected, encompassing three distinct professional fields: airline pilots, construction workers, and fitness trainers, with 20 individuals in each group. Participants were recruited during regular occupational health evaluations at outpatient clinics. Due to the sample's limited size, women were not included. The selection criteria excluded individuals with a prior history of psychiatric, neurological, autoimmune, inflammatory, or infectious conditions, in addition to those with malignancies or who had undergone pharmacological treatment within the preceding three months. Furthermore, none of the participants were using any supplements, and all appeared to be in good overall physical health. No subjects reported significant work-related stress or burnout during clinical interviews. The local ethics committee granted approval for this study (reference number: 2022/12), and all participants provided written informed consent.

Quantification of plasma neurotrophin levels

Blood samples were obtained through venipuncture and subsequently collected in Vacutainer tubes

Tab. 1. General characteristics of the study participants

Variable	Airline pilots (n = 20)	Construction workers (n = 20)	Fitness instructors (n = 20)	*p* value
Men	20	20	20	ns
Age, years	39.2 ± 3.3	38.9 ± 3.4	38.1 ± 2.1	ns
Body mass index, kg/m^2	23.8 ± 2.3	23.9 ± 2.3	23.4 ± 1.6	ns
Total cholesterol, mg/dL	204 ± 9	209 ± 8	202 ± 10	ns
Fasting plasma glucose, mg/dL	89 ± 8	88 ± 10	90 ± 13	ns

Abbreviation: ns, not significant.

Tab. 2. Plasma neurotrophin levels among construction workers, airline pilots, and fitness instructors

Neurotrophin	Construction workers (n = 20)	Airline pilots (n = 20)	Fitness instructors (n = 20)	*p* value
BDNF (ng/mL)	10.9 ± 1.8*	12.6 ± 1.5*,†	14.7 ± 2.1	<0.001
NGF (pg/mL)	134 ± 39*	152 ± 43*,†	178 ± 52	<0.001
NT-3(pg/mL)	396 ± 79	322 ± 84*,†	405 ± 96	<0.01
NT-4 (pg/mL)	49 ± 4	48 ± 5	50 ± 5	ns

Data are expressed as mean ± standard deviation. *$p < 0.05$ versus fitness instructors; †$p < 0.05$ versus construction workers. Abbreviations: BDNF, brain-derived neurotrophic factor; NGF, nerve growth factor; NT, neurotrophin; ns, not significant.

(Becton-Dickinson, Meylan Cedex, France) containing 0.12 mL (0.34 mol/L) of EDTA solution. After collection, these tubes underwent centrifugation at a force of 3000 g for 10 minutes to separate plasma. The plasma was then divided into aliquots and promptly stored at -20 °C for later analysis. Plasma NTs levels were measured using the Emax ImmunoAssay System (Promega, Madison, WI, USA). Each biochemical assessment was conducted in duplicate, with the results being averaged. The intra-assay and interassay coefficients of variation were below 6% and 8%, respectively. To minimize the risk of differential measurement errors, laboratory personnel were kept unaware of participants' work-related information.

Data analysis

The Kolmogorov-Smirnov test was employed to ascertain data normality. All continuous variables exhibited a normal distribution and were represented as mean ± standard deviation (SD). A one-way analysis of variance (ANOVA), followed by Tukey's *post-hoc* tests, was used to evaluate the continuous cross-sectional data between the three study groups. Categorical variables were displayed as counts and percentages and analyzed using the χ^2 test. The SPSS 20.0 software (IBM, Armonk, NY, USA) was utilized for statistical calculations. All tests were two-tailed, and results were deemed significant at $p < 0.05$.

RESULTS

The three study groups did not show significant differences in age, body mass index, total cholesterol, and fasting plasma glucose (Table 1). Upon examining plasma NTs concentrations (Table 2), fitness instructors displayed the highest concentrations of BDNF and NGF, with airline pilots ranking second, and construction workers showing the lowest levels. The differences between each group were statistically significant (Table 2). A significant decrease in NT-3 levels was observed in airline pilots compared to fitness instructors and construction workers, but no differences were found between the latter two occupations. Finally, NT-4 levels were similar across all three occupational groups (Table 2).

DISCUSSION

Our pilot research examined plasma NTs concentrations in three distinct professional groups, each with unique work environments and lifestyle influences, and uncovered three primary findings. Firstly, we observed a gradual increase in plasma BDNF and NGF levels, starting with the lowest amounts in construction workers, followed by airline pilots, and finally in fitness instructors exhibiting the highest concentrations of these two neurotrophic factors. Secondly, we found that airline pilots had lower NT-3 concentrations compared to both fitness instructors and construction workers, with no significant differences between the latter two groups. Finally, our observation revealed no significant differences in NT-4 levels, indicating that this particular neurotrophic factor may not be substantially impacted by the diverse job-related factors that distinguish the three professional groups.

BDNF and NGF – which are found in various brain regions, cerebrospinal fluid, neural and non-neural cells, peripheral tissues, and blood – are known

to promote differentiation, maturation, and survival of neurons in the nervous system, exhibiting a neuroprotective effect (Budni *et al.* 2015). Intriguingly, physical exercise has been shown to enhance NGF and BDNF expression in the hippocampus, potentially explaining its positive impact on memory improvement and prevention of neurodegenerative diseases (Bonanni *et al.* 2022). Moreover, an inverse relationship between baseline cardiorespiratory fitness and circulating BDNF levels has been reported (Fortune *et al.* 2019). While the existing literature on this topic in humans is not entirely consistent, Lippi *et al.* (2020) recently suggested that physical exercise could be an affordable and safe approach to stimulate BDNF release, thereby preserving or enhancing cognitive function. Additionally, Vakili *et al.* (2022) found that eight weeks of circuit training significantly raised serum NGF levels, along with improved cardiovascular and muscle endurance. Given this evidence, the elevated plasma BDNF and NGF levels observed in our fitness instructors can be attributed to their consistent participation in various training activities, such as yoga and strength training sessions. In contrast, airline pilots and construction laborers may not engage in the same intensity or consistency of physical activity as fitness instructors. While construction workers perform physically demanding tasks, their level of activity may not be as consistent or intense as that of fitness instructors. Intriguingly, airline pilots exhibited higher plasma BDNF and NGF levels than construction workers. Although piloting an aircraft is generally more sedentary than construction work, other factors could contribute to the observed differences in BDNF and NGF levels between these two groups. For example, airline pilots may encounter psychological stressors (Minoretti & Emanuele, 2023) known to elevate NGF serum concentrations (Lang *et al.* 2004) Conversely, construction workers face the risk of exposure to potentially harmful chemicals and hazardous environmental contaminants (Boal *et al.* 2020). Notably, Rodríguez-Carrillo *et al.* (2022) recently reported that BDNF could serve as a valid biomarker for the neurological effects of environmental chemicals. Furthermore, the complexity of construction site environments and the potential neglect of workers' emotions by managers may lead to emotional fluctuations (Chong *et al.* 2022), which could, in turn, result in decreased BDNF and NGF levels. Our study revealed another notable observation: airline pilots exhibited decreased plasma levels of NT-3 compared to both fitness instructors and construction workers, with no significant disparities between the latter two groups. A prior study suggested that NT-3 plays a crucial role in regulating natural REM sleep cycles (Yamuy *et al.* 2002). Consequently, it is possible that alterations in this neurotrophin could contribute to the disrupted sleep patterns and circadian rhythms frequently observed in the aviation profession (Minoretti & Emanuele, 2023). However, additional research is required to substantiate and further explore this hypothesis.

Our findings should be interpreted cautiously, considering several limitations. Our preliminary research did not investigate the underlying mechanisms responsible for the observed variances in plasma NTs levels among the three occupational groups. Among these, a key limitation is the absence of data concerning psychological questionnaires and physical activity levels. Such data could have provided invaluable insights into the mental health status and physical activity patterns of the participants, thereby enriching our understanding of their potential impact on plasma NTs levels. Additionally, we did not collect data on work capacity, a critical factor that can significantly influence an individual's job performance and health outcomes. Data on psychological and physiological parameters such as work environment and lifestyle factors were also not collected. These factors can play a significant role in shaping an individual's health status and understanding them could have allowed for a more nuanced interpretation of our laboratory findings. Moreover, data on stress coping mechanisms were not within the scope of our study, even though they can significantly impact an individual's plasma NTs concentrations. The lack of these data restricts our ability to fully assess the range of factors that might influence the outcomes observed in our study. The absence of this information stems from the fact that they were beyond the purview of routine occupational medicine consultations, which was the primary source of data for our pilot study. In future research, it may be beneficial to incorporate these aspects to gain a more holistic understanding of the factors influencing plasma NTs within the field of occupational health. We also acknowledge that the study's sample size was relatively small, emphasizing the need for additional replication to corroborate the findings. Finally, due to budget constraints, we opted to analyze the four conventional NTs, excluding ciliary neurotrophic factor and glial cell-line derived neurotrophic factor (Buckland & Cunningham, 1999) from our analysis.

In summary, our preliminary study suggests that plasma NTs in healthy individuals may significantly differ based on their occupation. Collectively, these results enhance our understanding of the impact that occupational factors have on an individual's NTs profile, potentially having crucial implications for their overall cognitive well-being.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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